

OCULUS KERATOGRAPH 4



USER GUIDE

System for measuring and analysing the cornea topography

Information about this User Guide

Thank you for your purchase and the trust you have placed in this OCULUS product. The Keratograph 4 has been manufactured and tested according to strict quality criteria. You have selected a modern and well-engineered product.

To ensure safe operation, it is essential that you use the device correctly. It is also intended that you make yourself familiar with the instructions manual which were also delivered with the device.

This User Guide provides you with detailed information about the topographic examination analyses and how the examination results are presented in particular.

Due to ongoing development, the diagrams shown may depict minor changes to the actual device delivered.

If you have any queries or would like additional information about your device, do not hesitate to call or send us a fax. Our service team will gladly assist.

OCULUS Optikgeräte GmbH
Management and workers



OCULUS is certified according to DIN EN ISO 9001:2000 and 13485:2003, setting high standards of quality where development, manufacture, quality assurance and service regarding the entire range of products are concerned.

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1 General notes

All data that are recorded during an examination with the keratograph are subsequently analysed and displayed by the keratograph software. In general, the results are output as numerical values as well as graphical representations. Different display modes are provided in the program for the various applications and different types of measurement (depending on how the keratograph is equipped), whereby you can switch back and forth among the display modes quickly and easily. Furthermore, the standard information for the individual displays can be customized.

1.1 Layout of the Documentation

A folder with several different documentation items is supplied with the keratograph:

QUICK GUIDE

- Measurement procedure in the form of a checklist.

INSTRUCTION MANUAL

- Design and operating concept of the unit
- Description of all measuring procedures on the Keratograph 4.
- Basic patient data management instructions.
- All safety-relevant advisements for using the Keratograph.

Attention

All safety-related information for use of the keratograph are given in the Operating Manual for the unit only. It is therefore imperative that you have read and understood the complete Operating Manual before using the keratograph.



USER GUIDE

- Analysis of the examinations by means of different display modes.
- Detailed documentation of the patient data management system.
- Description of the contact lens fitting program.
- Detailed information about the optional imaging and pupillography software.
- Parameter settings

1.2 Layout of the User Guide

The following topics are covered in the individual sections of the User Guide:

- **Chapter 1:** General notes.
- **Chapter 2:** Patient data management with more detailed information about the display modes in the Operating Manual.
- **Chapter 3:** Detailed descriptions in relation to the analysis of the topography examinations.
- **Chapter 4:** Contact lens fitting instructions.
- **Chapter 5–6:** Description of optionally available extension modules for the keratograph.
- **Chapter 7–8:** Basic configuration of the program and service functions.

1.3 Software Version

This User Guide describes the following keratograph software versions and the patient data management system:

- Patient Data Management: Version 6.02
- Keratograph software: Version 1.74



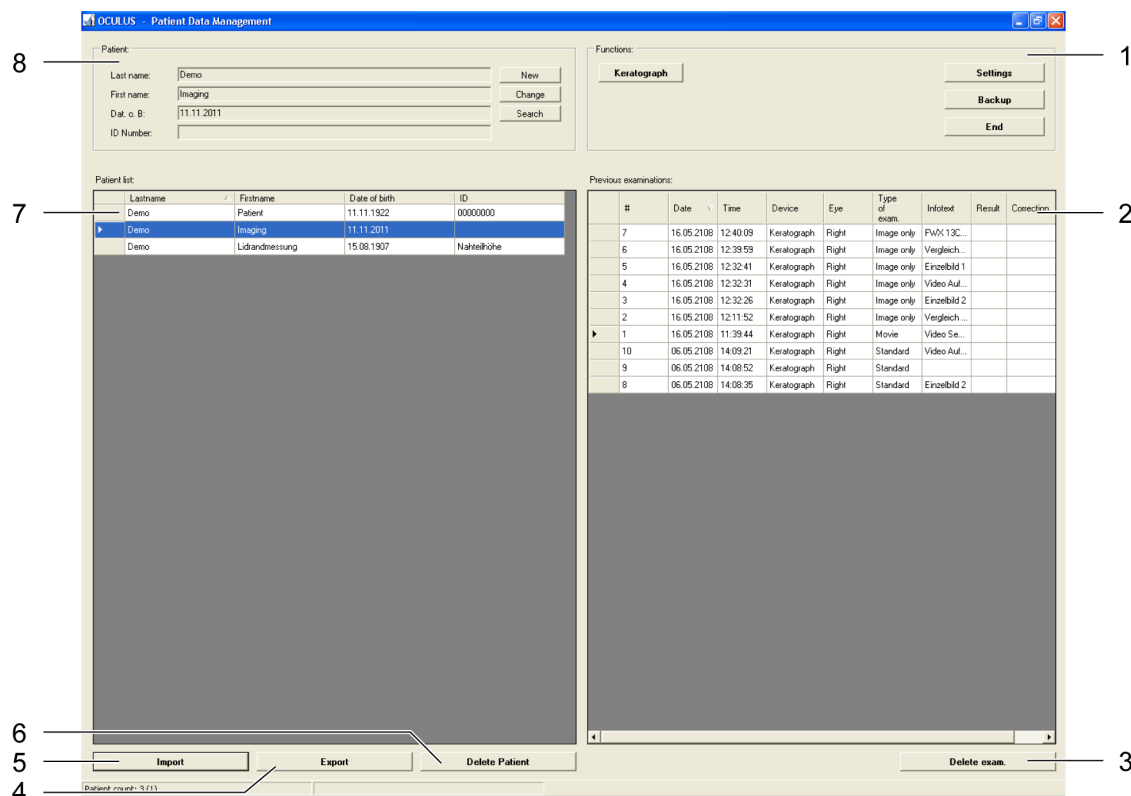
Note

- The patient data management software version is shown on the "Settings" screen **within the patient data management program** ([sect. 2.6, page 9](#)).
 - The software version of the keratograph program is shown on the "Change Settings" screen **within the keratograph program** ([sect. 7, page 105](#)).
-

2 Patient Data Management

2.1 Starting the Patient Data Management

After you have switched on the PC, it first loads the operating system. It will then display the user interface for "Patient Data Management".



1 "Functions" group box

2 Previous examinations

3 [Delete exam.] button

4 [Export] button

5 [Import] button

6 [Delete Patient] button

7 Patient list

8 "Patient" group box

Fig. 2-1: Patient Data Management

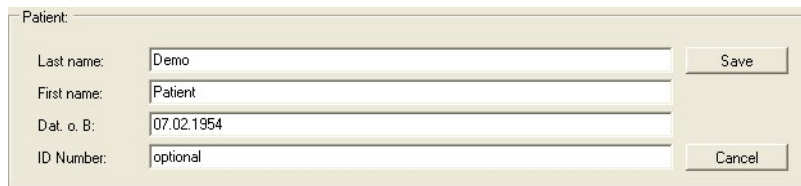
Note

To enter the Keratograph software, you must either enter a new patient into the "Patient" group box (8) or select an existing patient from the list (2).



2.2 Entering new patients

- ➔ To enter a new patient in Patient Data Management, click [New].
- ➔ Enter the patient's last name, first name and date of birth completely in the patient window (8).



Patient:

Last name: Demo

First name: Patient

Dat. o. B.: 07.02.1954

ID Number: optional

Save

Cancel

Fig. 2-2: Entering patients

- ➔ Optionally you can enter an ID number for the patient.
- ➔ To accept the entries you have made, click [Save]. The patient you have just entered now appears in the patient list.
- ➔ Select this new patient from the patient list and start the Keratograph software.

2.3 Selecting existing patients

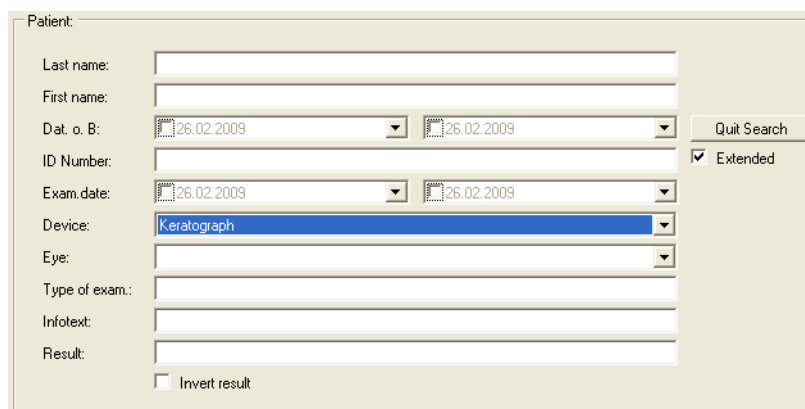
The patient list on the left-hand side of the screen displays all previously examined patients in alphabetical order.

- ➔ Click [Search] to quickly find the patient you require from the list.
- ➔ Enter the patient's name or the first letter of the name in the "Last name" field. The search can also be done using "First name" and "Dat. o. B.".
- ➔ Optionally you can search for the patient by entering his or her ID number, assuming that patient was assigned one when first entered.
- ➔ Click the appropriate entry in the list to transfer that patient's name to the patient window. This also brings up a list of any previous examinations for that patient in the examination window (bottom right side).

Extended patient search: [Extended] checkbox

- ➔ Activate the [Extended] checkbox.

The screen displays additional search parameters which reference previous examinations, for example. The procedure is similar to entering a new patient name.



Patient:

Last name:

First name:

Dat. o. B.: 26.02.2009 26.02.2009

ID Number:

Exam date: 26.02.2009 26.02.2009

Device: Keratograph

Eye:

Type of exam.:

Infotext:

Result:

Quit Search

☒ Extended

☐ Invert result

Fig. 2-3: Extended search

2.4 Manage patient data

2.4.1 Rename Patient Data

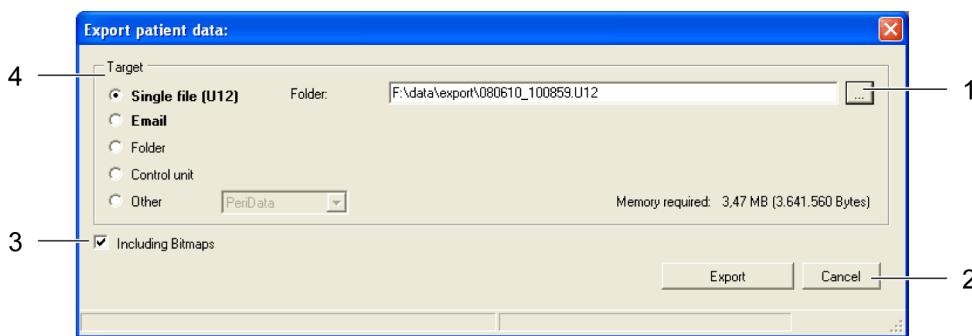
Patient data can be changed retroactively after it has been added.

- Press the [Change] button.
The entry boxes for patient data are now free; the cursor jumps to the "Last name" field.
- Change the entries in the individual boxes.
- To finish, press the [Save] button.

2.4.2 Exporting patient data

For example, patient and examination data can be exported for forwarding to another clinic.

- Select the patient and also one of the examinations in the respective list as required.
- Press the [Export] button below the patients list. The following dialog appears:



1 [...] button

2 [Cancel] and [Export] buttons

3 [Including Bitmaps] checkbox

4 Saving destination selection

Fig. 2-4: "Export patient data" dialog

Normally, you enter your preferred data import and export options once in the "Settings" area ([sect. 2.6.3, page 14](#)). Carrying out the following steps will then be partially omitted (for example, selecting the destination).



- Select the "Target" (4) you would like for the exported data.

Note

Ideally, patient data export takes place via the option "Single file (U12)". The patient data management system software must, however, be version 2.65 or later.



- Activate the checkbox [Including Bitmaps] (3), if it is presently deactivated.
- Press the [...] button (1) to the right next to the "Folder" box.

- In the dialog that appears, select the folder or the file to which the patient data should be exported.
- Confirm your selection with [OK] or [Save].
- To export the data, press the [Export] button (2).

2.4.3 Importing patient data

In case you keep patient data on a USB stick, you can import this data. The different software versions are compatible as a matter of principle, so that you can import data even if they have been exported from a later or earlier version of the patient data management system.



Note

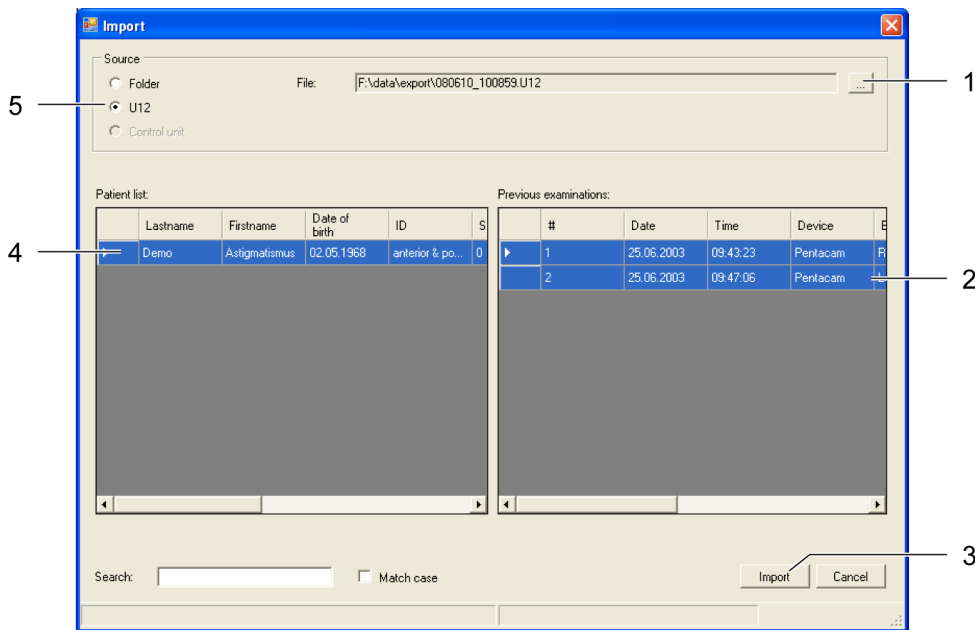
In order to be able to work with patient and examination data that have been generated with the help of optional software additions, such as, e.g. imaging or pupillometry, this additional software must be installed on the computer onto which the data are to be imported.



Note

Ideally, patient data import takes place via the option "Single file (U12)". The patient data management system software must, however, be version 2.65 or later.

-
- Press the [Import] button below the patients list. The following dialog appears:



- 1 [...] button
- 2 Previous examinations
- 3 [Import] button
- 4 Patient list
- 5 Select the source of the data

Fig. 2-5: "Import" dialog

Normally, you enter your preferred data import and export options once in the "Settings" area ([sect. 2.6.3, page 14](#)). Carrying out the following steps will then be partially omitted (for example, selecting the folder).



- ➔ Select the option (5) which contains the source data ("Folder" or "Single file (U12)").
- ➔ Press the [...] button (1) to the right next to the "Folder" box.
- ➔ In the dialog that appears, select the folder or the file which contains the patient data.
- ➔ Confirm your selection with [OK] or [Save].
The patients that are located and the associated examinations are displayed in the lower part of the dialog.
- ➔ To import the data, press the [Import] button (3). The data is then available in the user interface for "Patient Data Management".

2.5 Data backup

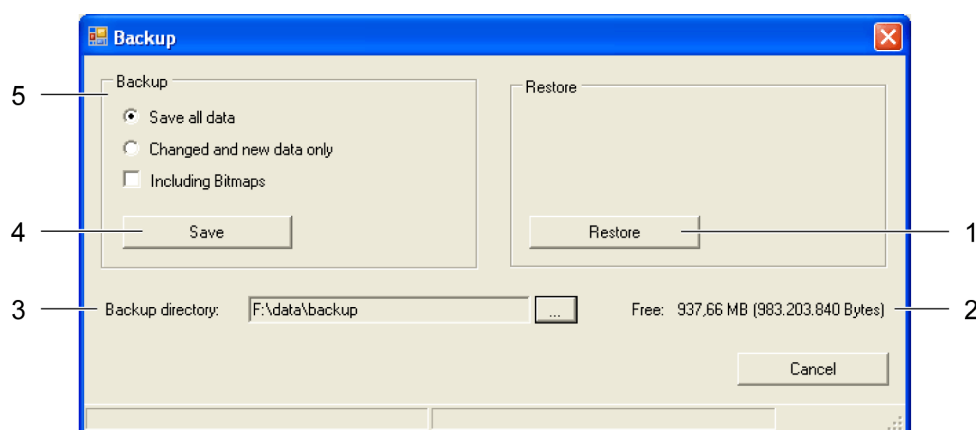
You should carry out a backup of patient and examination data at regular intervals. In case of a loss of data, you can reconstruct the data from a previously created backup with the help of this function. Since data backup takes several minutes depending on the scope of the database and the data to be backed up, a backup should be carried out when the PC and the device will not be needed.



The general rules for the creation of backup copies apply to backing up data with the help of the patient data management user interface. Storage of backup files should always be done on a separate system (e.g. on a USB stick with adequate capacity).

2.5.1 Backup data

→ In the upper right part of the patient data management user interface, press the [Backup] button. The following dialog appears:



1 [Restore] button

4 [Save] button

2 Display free storage space.

5 Backup data selection

3 Backup folder and [...] button

Fig. 2-6: "Backup" dialog

→ Select whether all of the data or only changed data should be backed up.



Note

The patient data management user interface internally selects all backed up datasets. Selecting the option "Changed and new data only" only backs up those datasets which were not saved during a previous backup.

→ Select whether the examination data should be backed up including camera images.



Note

If the bitmaps are **not** saved too, then the camera images captured during the examination can no longer be displayed after the data from this data backup have been restored.

→ Press the [...] button to the right next to the "Backup directory" box (3).

→ In the dialog that appears, select the folder to which the data should be backed up.

→ Confirm your selection with [OK].

- To back up the data, press the [Save] button (4). The previously selected data will then be backed up to the corresponding folder.

2.5.2 Reconstruct data

If a loss of data occurs, the data from a previous backup can be imported again into the patient data management user interface.

- Press the [...] button to the right next to the "Backup directory" box (3).
- In the dialog that appears, select the folder which contains the backup data.
- Confirm your selection with [OK].
- To import the data, press the [Restore] button (1). All data in the corresponding folder will be transferred to the patient data management user interface.

2.5.3 Automatic backup

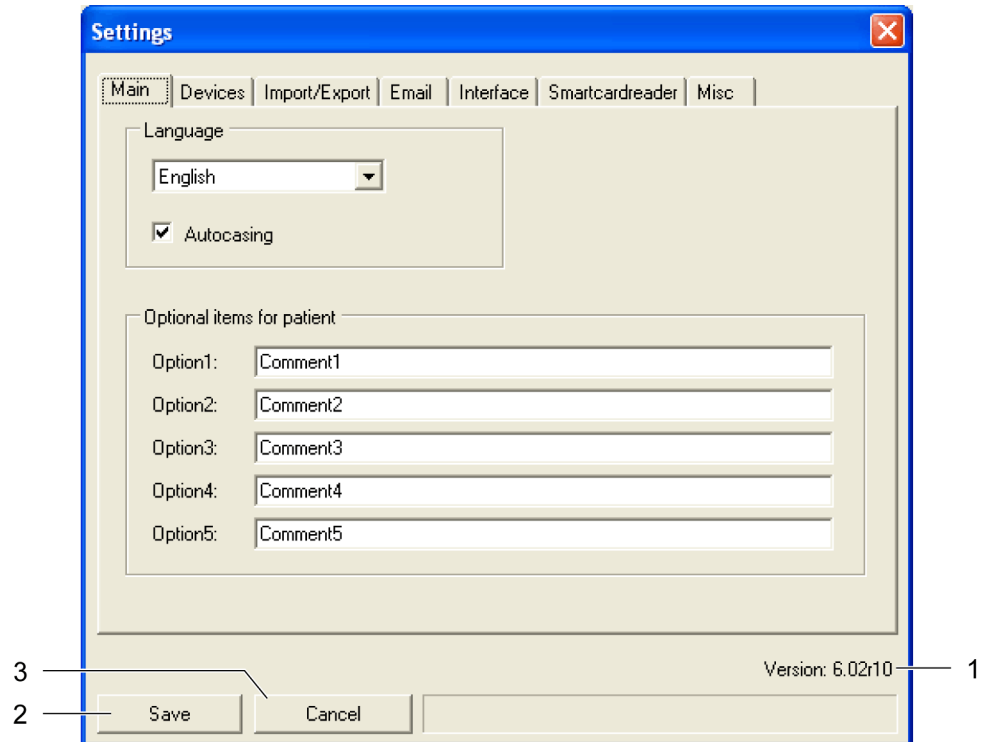
Besides the manually executed backup, there is also the option to carry out a backup when the patient data management user interface is closed. The settings required for this can be found in the "Settings" area ([sect. 2.6.3, page 14](#)).

2.6 Settings

Basic specifications for working with the patient data management user interface can be made in the "Settings" area.

- In the upper right part of the patient data management user interface, press the [Settings] button.

The "Settings" page appears with the "Main" tab in the foreground.



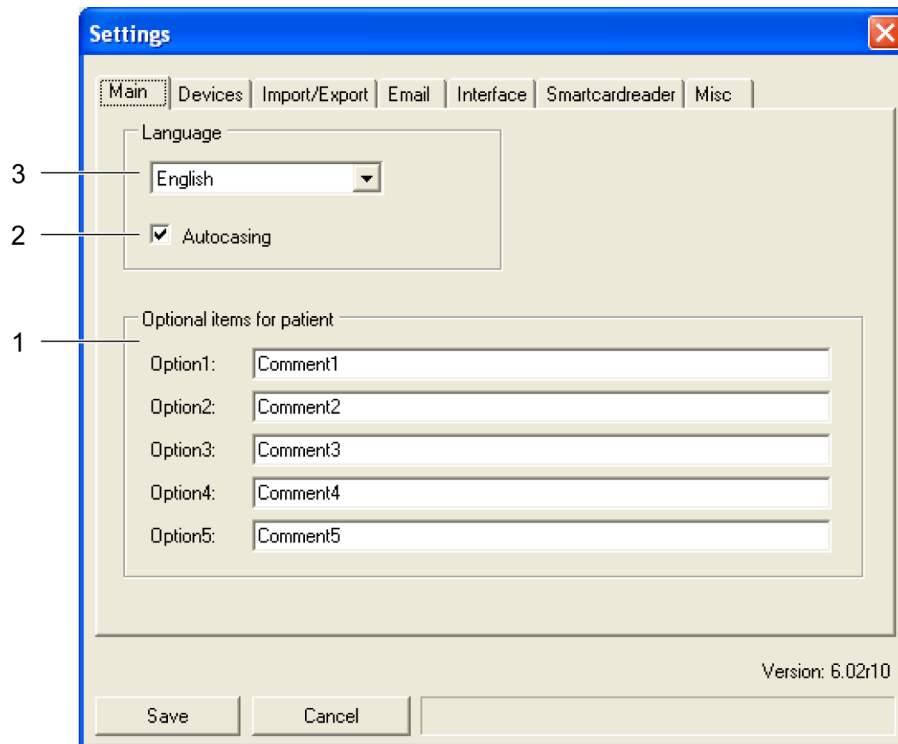
- 1 Patient data management user interface program version 3 [Cancel] button
2 [Save] button

Fig. 2-7: "Settings" screen, "Main" tab

The following information and buttons are available to you on all of this page's tabs:

- The program version of the patient data management user interface is displayed below and to the right (1).
- There are two buttons below and to the left for saving (2) or discarding (3) the changes that have been made. **All** changes are saved or discarded, and then the page is closed.

2.6.1 "Main" tab



1 Optional patient entries

2 [Autocasing] checkbox

3 "Language selection" dropdown list

Fig. 2-8: "Settings" screen, "Main" tab

"Language" group box

- ➔ Select the language in the "Language" dropdown list (3) to be displayed on the patient data management user interface page.
- ➔ Activate the [Autocasing] checkbox (2) as required. If the checkbox is active, the first letter of a patient's name and last name is **always** converted into a capital letter.

"Optional items for patient" group box

Besides the five standard attributes of first name, last name, date of birth, gender, and ID, up to five additional attributes can be freely defined.

- ➔ Enter the identifier for the attribute in one of the boxes option 1 to option 5, for instance "Comments".

To be able to carry out entries for the newly defined attributes, proceed as follows:

- ➔ Click with the right mouse button on the patient list and open the associated context menu.
- ➔ Select the desired attribute, e.g. "Comments".

Patient list:

	Lastname	Firstname	Date
▶	Demo	Astigmatismus	02.05.1968
	Demo		05.09.1966
	Demo		07.04.1976
	Demo		06.01.1940
	Demo		15.09.1967
	Demo		24.03.1939
	Demo		19.10.1932
	Demo		19.10.1932
	Demo		19.01.1932
	Demo		22.04.1932
	Demo		18.06.1932
	Demo		25.11.1932
	Demo		20.04.1932
	Demo	Iol	23.05.1932
	Demo	Keratoconus	02.02.1932
	Demo	Keratoconus	05.01.1932

Context menu:

- Resize columns
- ☒ Lastname
- ☒ Firstname
- ☒ Date of birth
- ☒ ID
- Sex
- Comment**
- Comment2
- Comment3
- Comment4
- Comment5

The context menu will close, and the attribute "Comments" will also be displayed in the upper part of the entry boxes for patients (1) as well as in the patient list (2).

OCULUS - Patient Data Management

Patient:

Last name: Demo

First name: Astigmatismus

Dat. o. B.: 07.04.1976

ID Number: high chamber angle

Comment:

New

Change

Search

Patient list:

	Lastname	Firstname	Date of birth	ID	Comment
▶	Demo	Astigmatismus	02.05.1968	anterior & posterior	
	Demo	Astigmatismus	05.09.1966	anterior & posterior	
	Demo	Astigmatismus	07.04.1976	high chamber angle	
	Demo	Cataract	06.01.1940	central powdery	
	Demo	Cataract Congenital	15.09.1967		
	Demo	Flat Ant. Chamber	24.03.1939		
	Demo	Glaucoma, Narrow Angle	19.10.1932	Cataract	

1 Attribute "Comments" as entry box

2 Attribute "Comments" in the patient list

1 Attribute "Comments" as entry box

2 Attribute "Comments" in the patient list

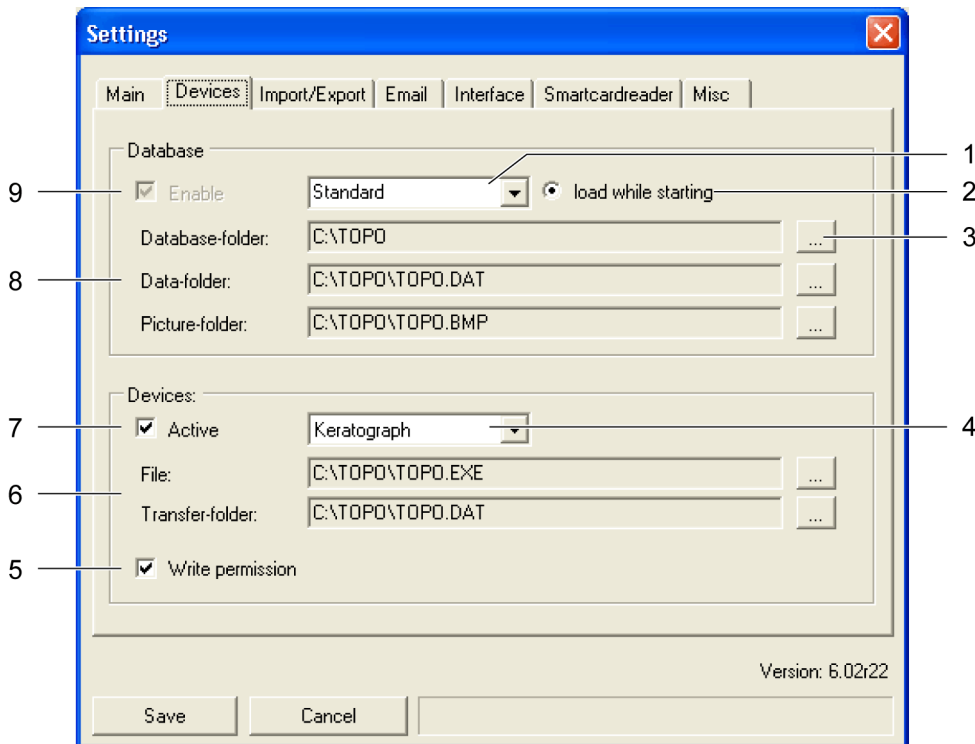
Fig. 2-9: User-defined attribute "Comments"



Note

Selection of attributes occurs analogously in the context menu. The currently selected attributes are marked with a check.

2.6.2 "Devices" tab



1 Dropdown list for selecting a database

2 "load while starting" option

3 Folder selection

4 Dropdown list for selecting a device

5 [Write permission] checkbox

6 Path for the currently selected device

7 Checkbox for activating a device

8 Path for the database

9 Checkbox for activating a database

Fig. 2-10: "Devices" tab

"Database" group box

Different users can be set up for different databases.

- ➔ In the dropdown list for selecting a database (1), choose the entry "Standard" or "User 1-4" that you would like to edit.
- ➔ Choose the corresponding path for the database, data, and images via the individual buttons for folder selection (3).
Normally, two different folders are created and displayed for data and image during installation (8).
 - **For data:** Name of the device plus the .DAT identifier
 - **For images:** Name of the device plus the .BMP identifier
- ➔ For each user, activate whether the associated database should be actively switched on or not (9).

In case more than one database is active, an additional dropdown list appears on the main page of the patient data management user interface. You can activate a user (or the assigned database) in this list. The patient list and the associated examinations are updated when the active user is changed.

- You can also activate the option "load while starting" (2) for exactly one user. The associated database will then normally be loaded at start of the patient data management user interface and is pre-selected.

"Devices" group box

Settings for connected devices can be carried out in the group box.

- In the dropdown list, select the desired device (4).
- If the device is in fact connected, then activate the checkbox [Active] (7).
- Choose the path to the associated device's application file via the folder selection button.

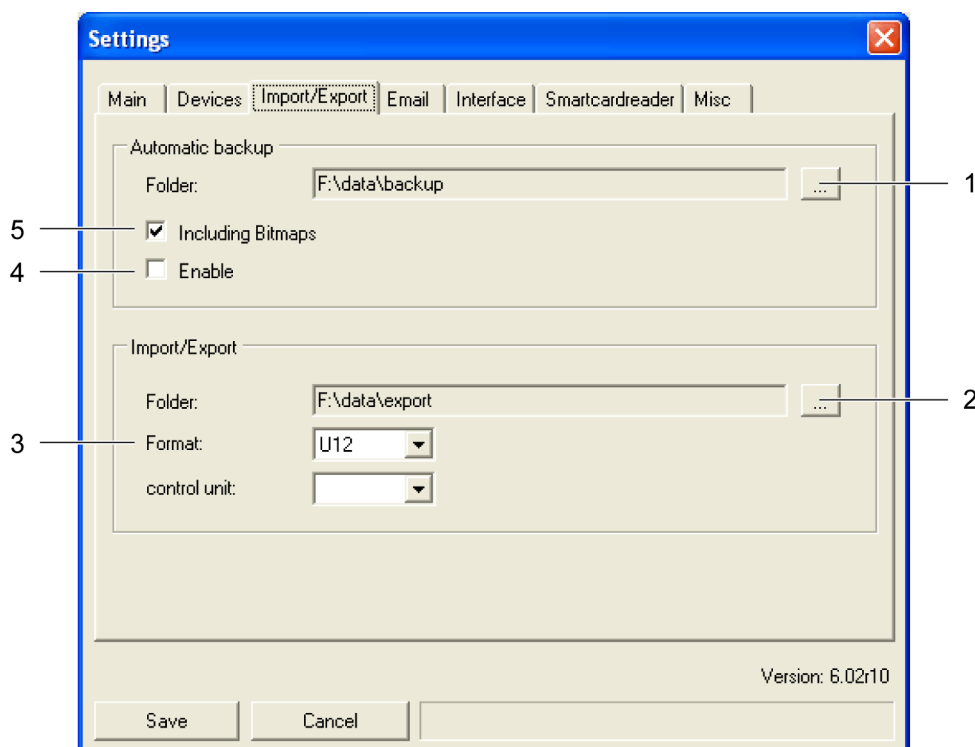
To save patient and examination data in the database, this will initially be created in the so-called "Transfer folder". This folder is always created locally on the PC.

- Choose the transfer folder via the folder selection button. This should correspond with the name of the device and the .DAT extension.

You can also specify settings for devices which are not connected to the PC.

- Activate the checkbox [Write permission] for the devices that are in fact connected to the PC.

2.6.3 "Import/Export" tab



1 Automatic backup folder

2 Select import/export folder

3 Standard format for import and export

4 [Enable] checkbox

5 [Including Bitmaps] checkbox

Fig. 2-11: "Import/Export" tab

"Automatic backup" group box

Besides the manually executed backup ([sect. 2.5.1, page 8](#)), there is also the option to carry out a backup when the patient data management user interface is closed. The settings required for this can be specified in the group box.

- Select the folder via the folder selection button (1) where the data should be saved during an automatic backup.
- Selected the checkbox [Including Bitmaps] (5) if the camera images should also be backed up.
- Activate the checkbox [Enable] (4), if the automatic backup should be executed with the settings specified.

"Import/Export" group box

You can enter settings in this group box for import and export of patient data management user interface data.

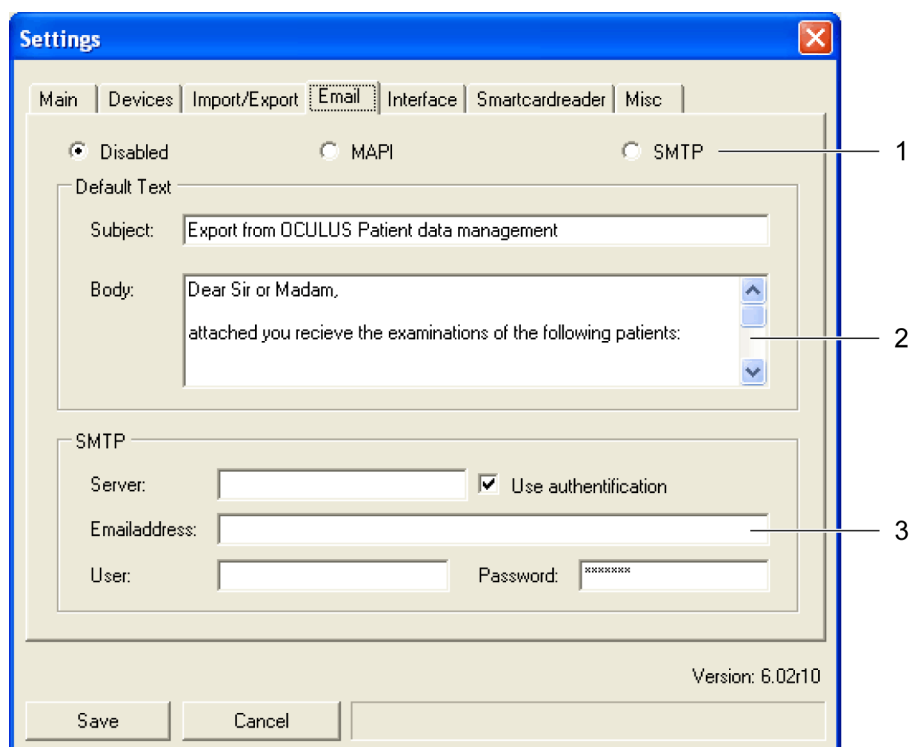
Note

The settings specified in this tab for import and export of data can be overwritten. Only typical settings are entered here.



-
- Select the folder via the folder selection button (1) which should be pre-selected as the standard for import or export.
 - In the "Format" dropdown list (3), select whether import or export should normally occur in one folder or in a single file (U12).

2.6.4 "Email" tab



1 Mail connection selection

3 SMTP connection selection

2 Standard text for subject and body text

Fig. 2-12: "Email" tab

With the three options buttons in the upper part of the tab (1), you can determine whether the email connection is active, and if it is, how the transfer of data should take place.

- ➔ Activate the option "MAPI" if an email program (e.g. Microsoft Outlook) is installed on your PC and if the data should be sent using this program.
- ➔ Activate the option "SMTP" if **no** email program is installed on your PC but you would still like to send the data via email. In this case, additional entries are necessary in the "SMTP" group box.

"Default text" group box

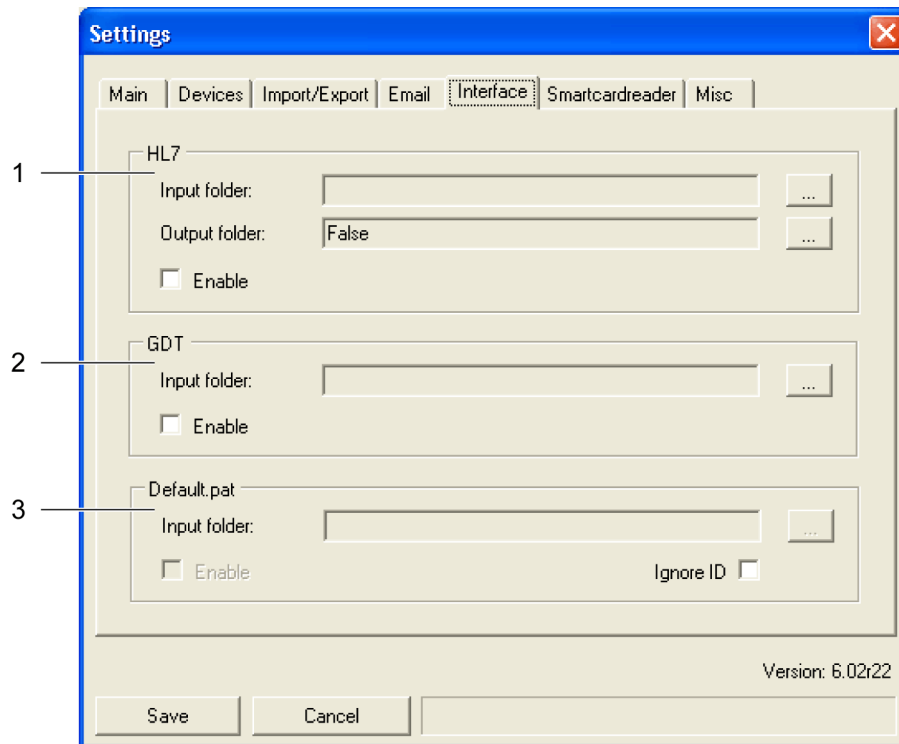
- ➔ Enter the text in the "Subject" and "Body" (2) boxes which should normally be pre-entered when email is sent. You can adjust this text before email is actually sent (e.g. particular to patients or examinations).

"SMTP" group box

In case no email program is installed on the computer, several entries must be made here to send emails.

- ➔ Contact your system administrator if you have questions about the individual entries.

2.6.5 "Interface" tab



1 Settings for HL7

2 Settings for GDT

3 Settings for Default.pat

Fig. 2-13: "Interface" tab

Use this tab to enter the folder for different interface types and to activate or deactivate them. The interfaces are used to read in patient data from other systems.

HL7

For interface HL7 (1), you select both the input and the output folder. When the patient data management system is started, new patient data are permanently searched for in the input file. If new data are present, they are automatically loaded and the examination program is started. After the examination has been concluded, the data are saved to the output folder and are available to the external program for further processing.

→ Activate the HL7 interface by activating the appropriate [Enable] checkbox.

GDT

For the GDT interface (2) you only select an input folder. When the patient data management system is started, new patient data are permanently searched for in the input file. If new data are present, they are automatically loaded and the examination program is started.

→ Activate the GDT interface by activating the appropriate [Enable] checkbox.

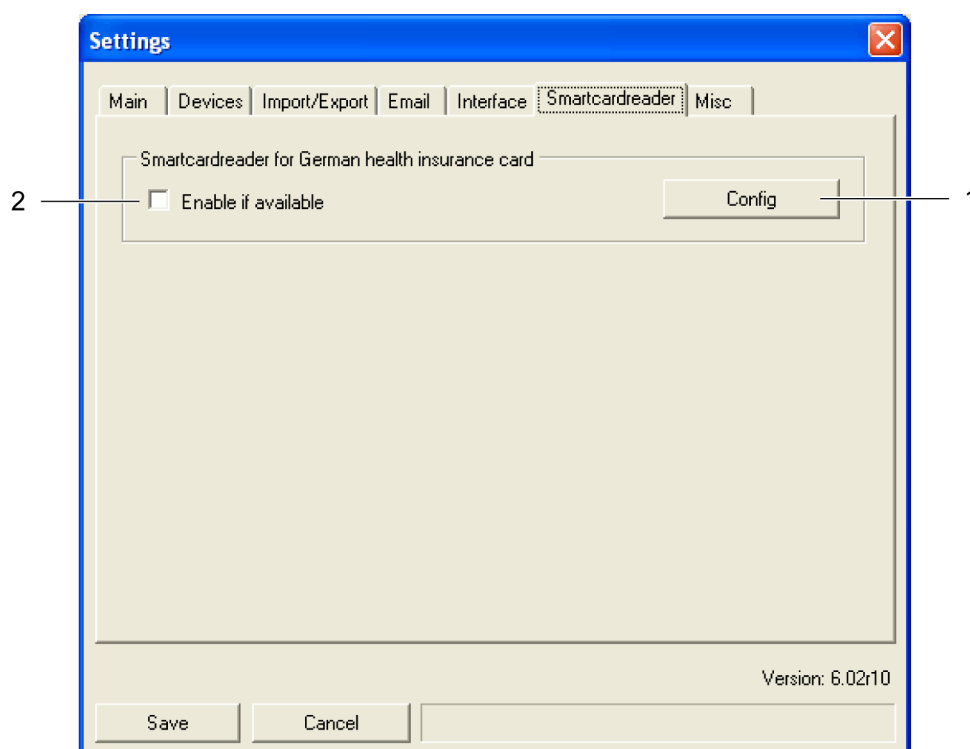
Default.pat

For the Default.pat interface (3), you do not need to make any inputs except for in the checkbox [Ignore ID].

- Activate this checkbox if the patient ID supplied by the external program is to be ignored.

No other inputs are necessary. Every time the patient data management system is started, a "Default.pat" file is searched for in the installation directory for the connected devices. When this file is present, it is analysed accordingly and the examination program is started with the patient data that are stored there.

2.6.6 "Smartcardreader" tab



1 [Config] button

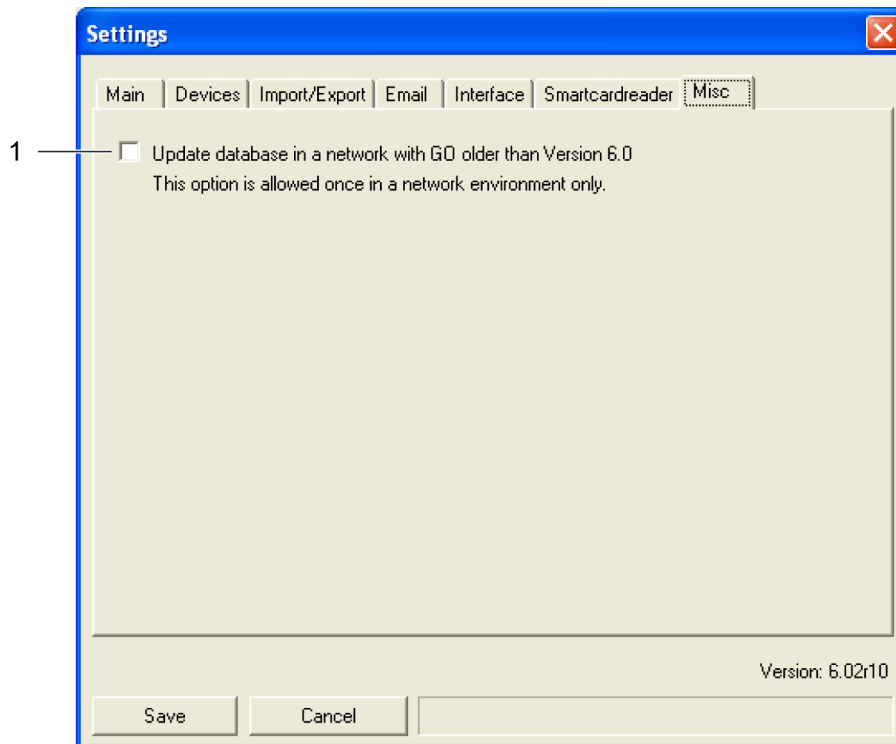
2 [Enable if available] checkbox

Fig. 2-14: "Smartcardreader" tab

You can configure a smartcard reader on this index so that you can directly import patient data via the patient's insurance card into the patient data management user interface. First, you have to configure the smartcard reader (usually only once).

- Press the [Config] button (1). A page appears for you to select the type of smartcard reader you are using.
- Select the [Enable if available] checkbox (2) to activate the smartcard reader.

2.6.7 "Misc" tab



1 Checkbox for managing a database

Fig. 2-15: "Misc" tab

Patient data management is implemented in two different versions: V2.x and V6.x. In principle, implementing both versions on the same network should be avoided. In any case, if the higher technical requirements of the new version V6.x cannot be circumvented, then the corresponding settings must be specified on this tab.

- Activate the checkbox on this tab (1) on **exactly one PC** with an installed V6.x version.
- Make sure that this checkbox is **not** active on any other PC which has version V6.x of the patient data management user interface installed.

This ensures that the database is automatically adjusted if another PC with the older patient data management V2.x is installed.

3 Analysis of the Topographic Examinations

The keratograph software provides various ways of displaying the results of topographic examinations on the screen. In this chapter, the individual displays will be described in series in which they can be selected in the menu "Display".

Most of these display options are composed of different individual displays. These individual displays are described in the sequence that they appear in the respective display option. The description of further display options (which contain the same individual display) references the corresponding sub-chapter where you will find the description of the individual display.

A printout of the screen page that is being displayed can be generated with the "Print" function in the menu bar at the top right.

Note

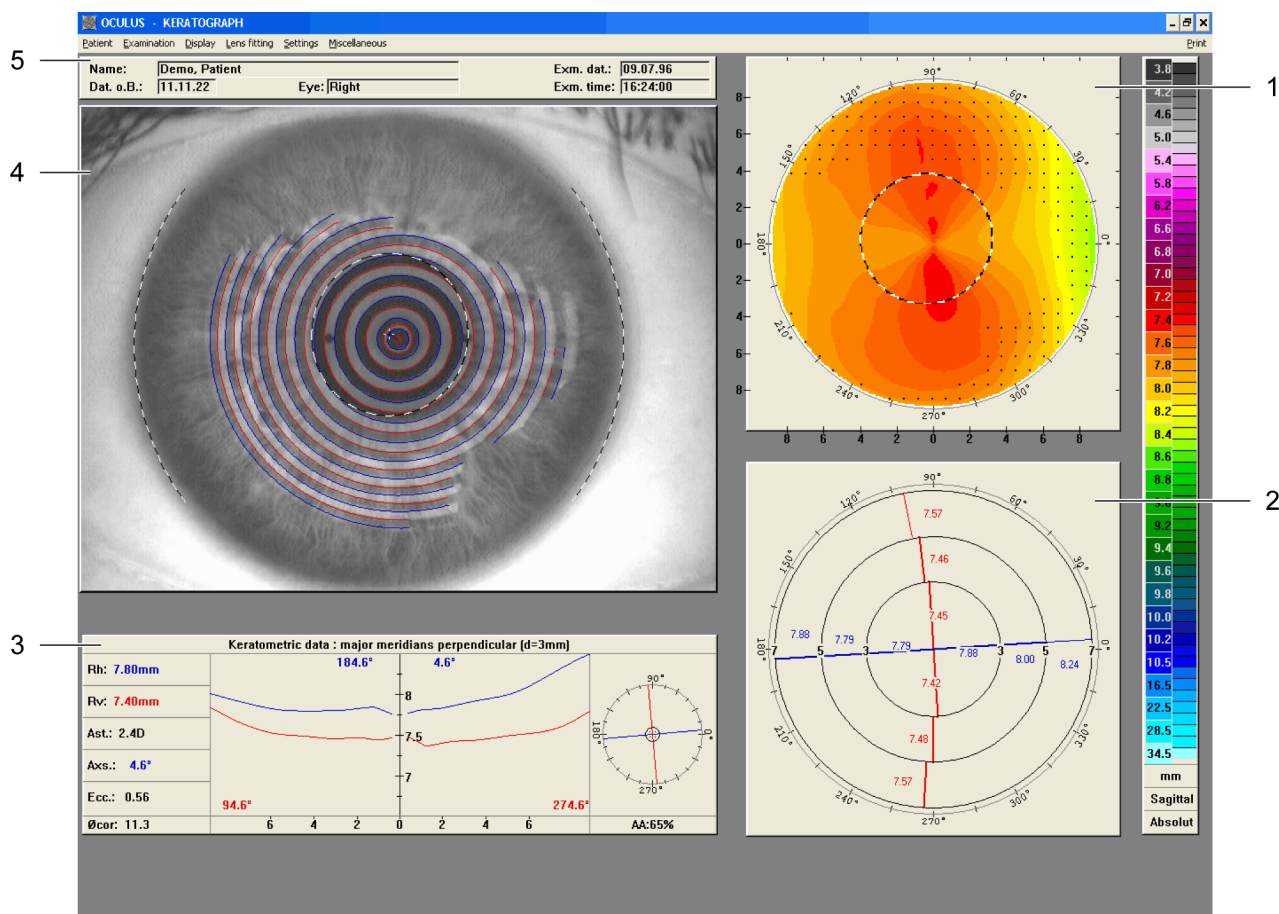
The background of the screen can be shown in white for the printout ([sect. 7.1.11, page 111](#)).



3.1 Overview display

Multiple analysis presentations are displayed on the overview screen to give you a quick overview of the measured corneal topography.

➔ In the "Display" menu, select the menu item [Overview].



- 1 Topography map
- 2 Numeric extremes map
- 3 Keratometric data
- 4 Scaled down camera image
- 5 Patient and examination data

Fig. 3-1: Overview display

3.1.1 Patient and examination data

Name:	Demo, Patient	Exm. dat.:	09.07.96
Dat. o.B.:	11.11.22	Eye:	Right
		Exm. time:	16:24:00

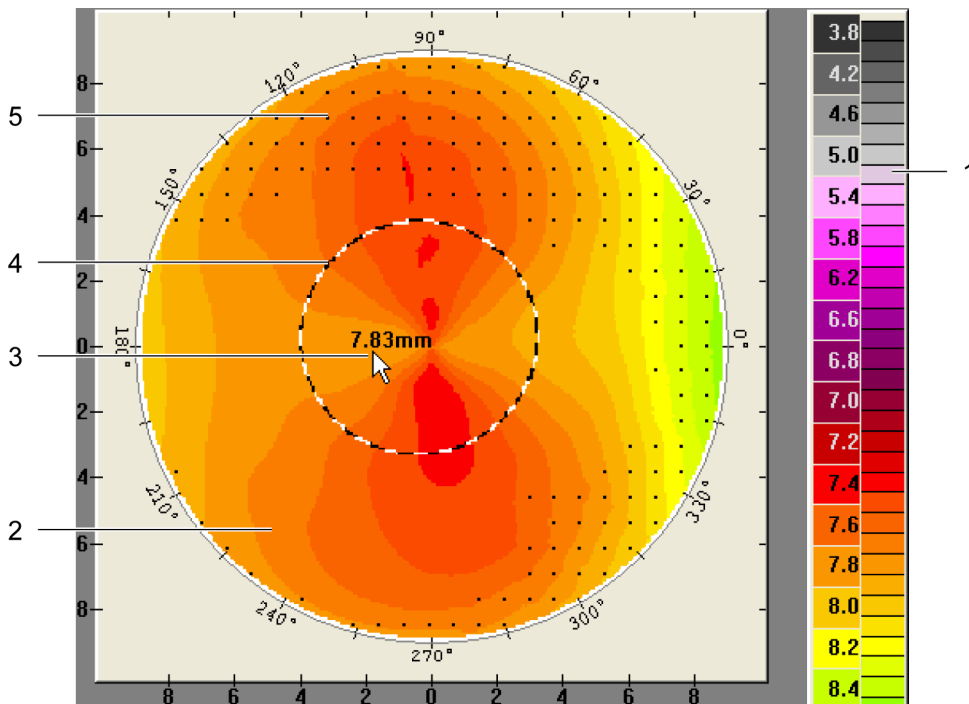
Fig. 3-2: Patient and examination data

This individual display (5) shows the most important patient and examination data.

- Last name and first name
- Date of birth
- Eye examined
- Examination date and time

3.1.2 Topography map

The measured corneal topography is output as a color map (2).



- 1 Color bars
- 2 Map
- 3 Current cursor position
- 4 Pupillary margin
- 5 Area not measured

Fig. 3-3: Color topography map

The measured, local radii of curvature are assigned a color in this map. The exact assignment can be seen on the corresponding color bar (1). Areas that were not measured are interpolated by the keratograph software and are shown with black dots (5). If you selected the option "Original" on the "Change settings" screen, the areas that were not measured are shown as white areas ([sect. 7.1.3, page 107](#)).

By selecting a specific point in the map (3) with the left mouse button, the value at the selected position is displayed directly.

Below the color bar, the following information is provided:

- The data is presented as a refractive power in diopters or as radii of curvature in mm.
- The data is presented as tangential or sagittal radii of curvature.
- Absolute assignment of colours to the values (display **Absolute**) ascribes each color a fixed, assigned value. Relative assignment (display **Relative**) assigns the same color to the mean value as with absolute assignment. Every color, however, is assigned a value which is variably defined with the selected increment. The selected increment is output as a numeric value in front of the unit of measure mm or diopters. You make these settings on the "Change settings" screen in the "Color scale stepping" box ([sect. 7.1.5, page 107](#)).

Adjusting color bar settings

- ➔ Click with the left mouse button on the color bar to adjust the indicated setting.

The "Change settings" ([sect. 7.1.5, page 107](#)) screen, on which you can make the desired settings, opens.

3.1.3 Numeric extremes map

The numeric extremes map (2) gives you a quick, numeric view of the corneal topography.

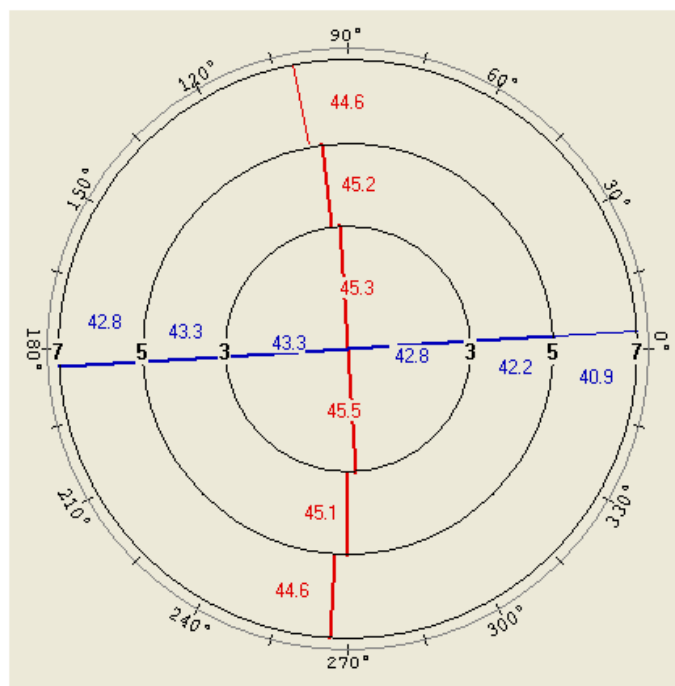


Fig. 3-4: Numeric extremes map

The minimum and maximum radii of curvature are shown in this map on rings with diameters of 3 mm, 5 mm and 7 mm around the topographic center. The maximum curvatures are shown in red, the minimum curvatures in blue. The degree of astigmatism and the corresponding angle position are thus easy to identify.

3.1.4 Keratometric data

Detailed examination results are displayed in the bottom section of the screen (3).

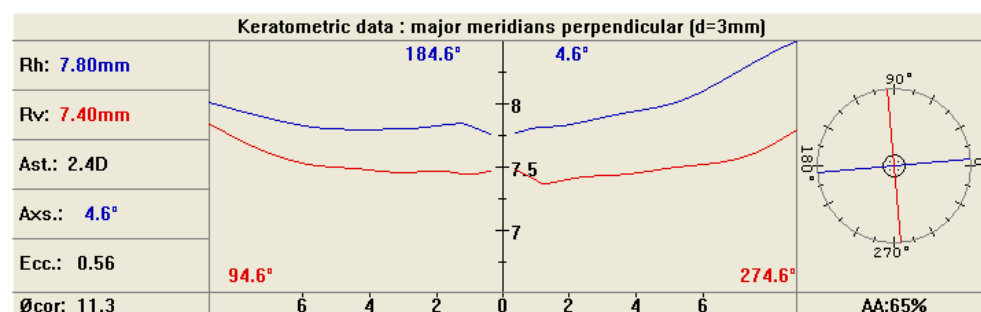


Fig. 3-5: Keratometric data

The location of the two major meridians on the 3 mm-ring of the cornea are output in the right section of the chart. By definition, these are always perpendicular to each other. The following measured value is displayed below that:

- **AA:** Percentage of the effectively measured, i.e. not interpolated, corneal surface (= Analysed Area)

The middle section of the chart shows the progression of the curvature on these major meridians from the center ("0") to the periphery.

The following measured values are shown in the left section of the chart:

- **Rh:** Horizontal radius of curvature in the center, shown as a radius value in mm or as a refractive power in diopters.
- **Rv:** Vertical radius of curvature in the center, shown as a radius value in mm or as a refractive power in diopters.

Note

Switching from displaying the information as a radius of curvature or as a refractive power and vice-versa is done on the "Change settings" screen ([sect. 7.1.6, page 108](#)). You can also set there whether the horizontal and the vertical, or the flat and the steep radius of curvature are to be displayed.



-
- **Ast.:** Astigmatism of cornea in the center.
 - **Axis:** Axis position of the flat meridian.
 - **Ecc.:** Mean eccentricity of the cornea
 - **cor:** Cornea or iris diameter

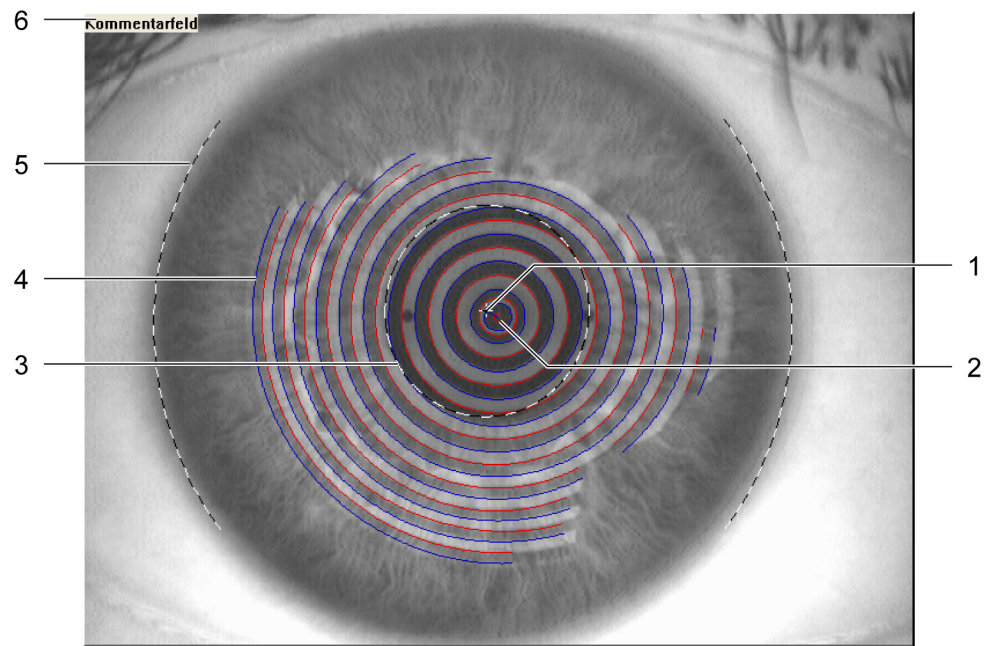
Note

The fixation point deviation, i.e. the distance between the topographic center and the center of the pupil is also displayed as a numeric value on the "Contact lens fitting" screen ([Fig. 4-1, page 73](#)).



3.1.5 Scaled down camera image

The camera image that was captured during the measurement is shown at a reduced size.



1 Center of the pupil
2 Optical axis
3 Pupillary margin

4 Edges of the rings
5 Corneal margin
6 Info text field

Fig. 3-6: Scaled down camera image

In addition to the camera image, the following details are also displayed:

- **red-blue (4):** Ring edges determined by the image processor
- **white-black (3 and 5):** Cornea and pupil
- **white-black cross (1):** Center of the pupil

Creating an Info Text

You can enter a comment or info text at the top edge of the camera image (4).

➔ Click in the top area of the camera image with the mouse. A dialog box opens.

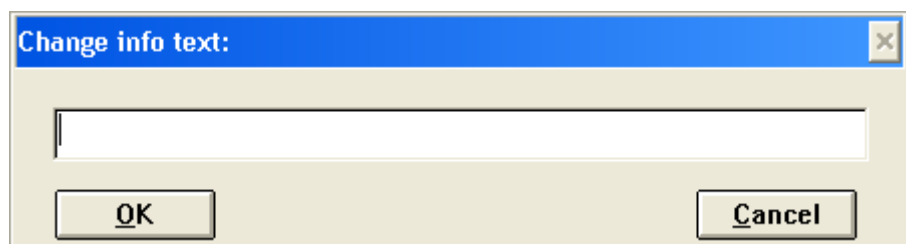


Fig. 3-7: "Change info text" dialog

➔ Enter the desired comment or info text and press [OK] to confirm.



Note

The info text is also displayed later when the examination is reloaded.

Manual Measuring Function

You can measure the distance between any two points in the camera image with this measuring function.

- Click the left mouse button on the point in the camera image at which you want the measurement to start. The mouse pointer is now shown as a cross.
- Now move the mouse pointer and the distance between the start point and the current mouse position will be displayed in mm.
- Once you have reached the end point for the measurement, click the left mouse button again. The arrow head and the associate distance will now be permanently displayed.

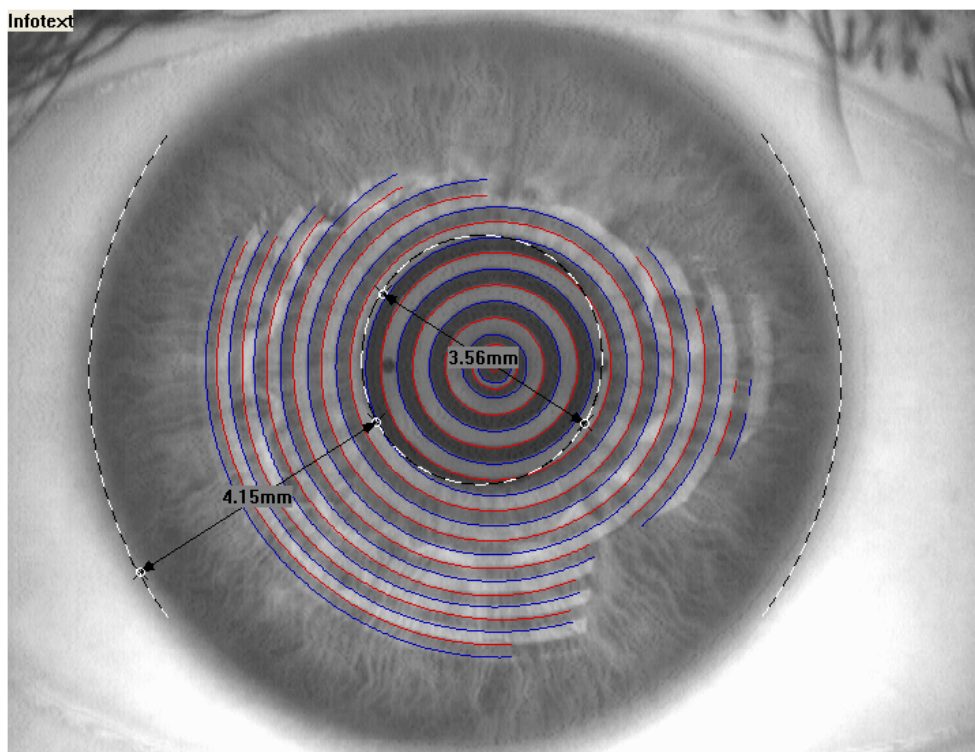


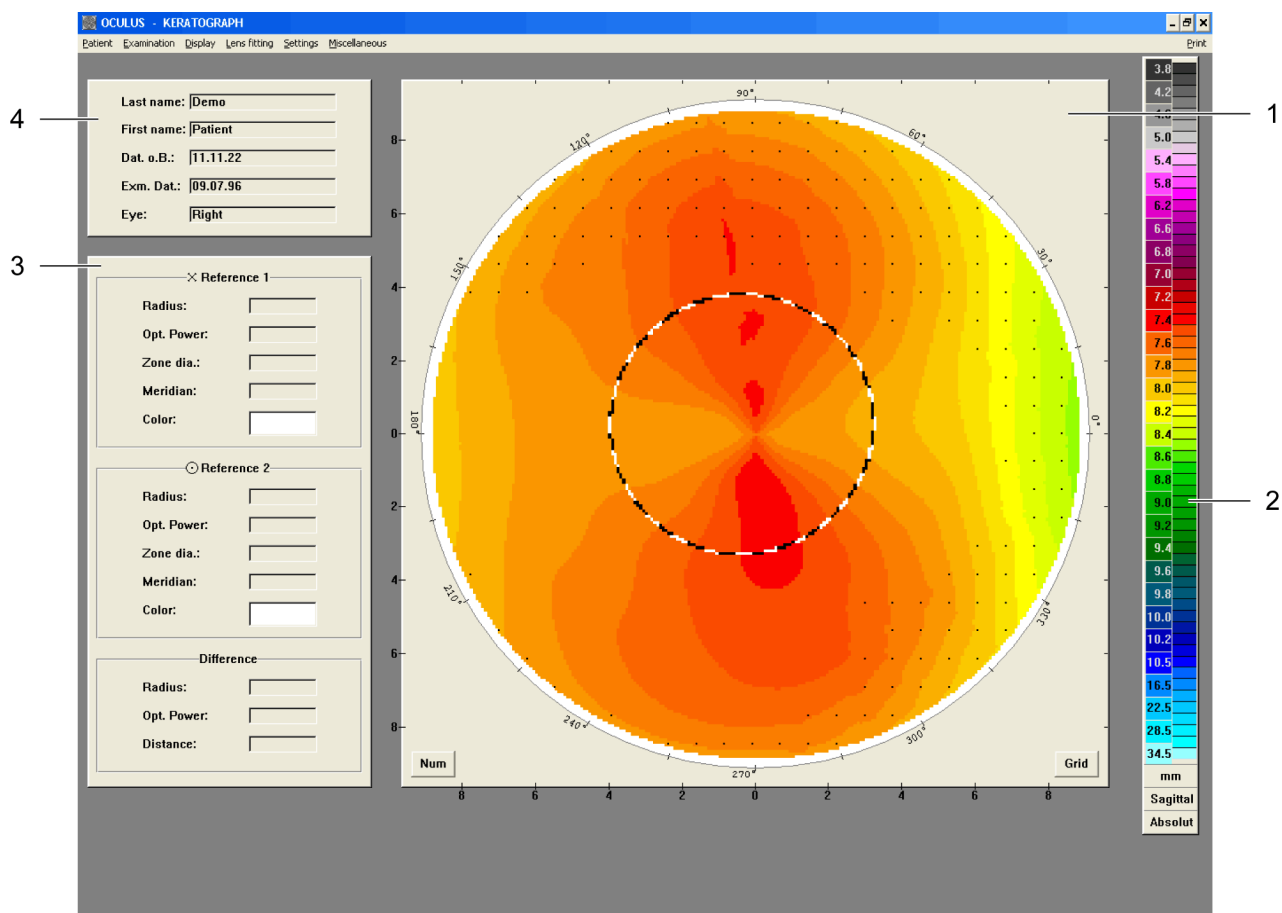
Fig. 3-8: Measuring function in the camera image

- To delete all dimensional arrows, select the menu item [Overview] in the "Display" menu again.

3.2 Color map large

The program offers the option of displaying the topography map ([sect. 3.1.2, page 23](#)) in large format on the screen.

- In the "Display" menu, select the menu item [Color Map (large)]. The following tab appears.



1 Topography map

2 Color bars

3 Numeric values of the measured points

4 Patient and examination data

Fig. 3-9: "Color Map (large)" display

This presentation makes interactive analysis of the color topographic map possible. In general, this map is the same as the individual map in the overview ([sect. 3.1.2, page 23](#)). Here, you can also output different numeric values for two measuring points.

- ➔ Click in the map with the left mouse button to define measuring point 1. Measuring point 1 is shown as a "cross". Each additional click with the left mouse button redefines measuring point 1.
- ➔ Click in the map with the right mouse button to define measuring point 2. Measuring point 2 is shown as a "circle".

The following numeric values are output for these two measuring points:

- **Radius:** Radius of curvature at the measuring point in mm.
- ➔ **Opt. Power:** The optical power in diopters calculated from the radius of curvature.
- **Zone dia:** Diameter of the circle on which the measuring point lies in mm.
- **Meridian:** Position of the meridian of the measuring point in degrees.
- **Color:** The color assigned to the curvature in the color map.

When you have defined two measuring points, the following measurement differences are also output at the bottom left.

- **Radius:** Radius of curvature at measuring point 1 - Radius of curvature at measuring point 2

- **Opt. Power:** Calculated optical power at measuring point 1 - Calculated optical power at measuring point 2
- **Distance:** Distance measuring point 1 - measuring point 2

Other Settings

- ➔ Press the [Grid] button at the bottom right of the color map to display or hide a scaled polar coordinate system.
- ➔ Press the [Num] button to display or hide the numeric values for the radii of curvature or the optical powers in the topography map.

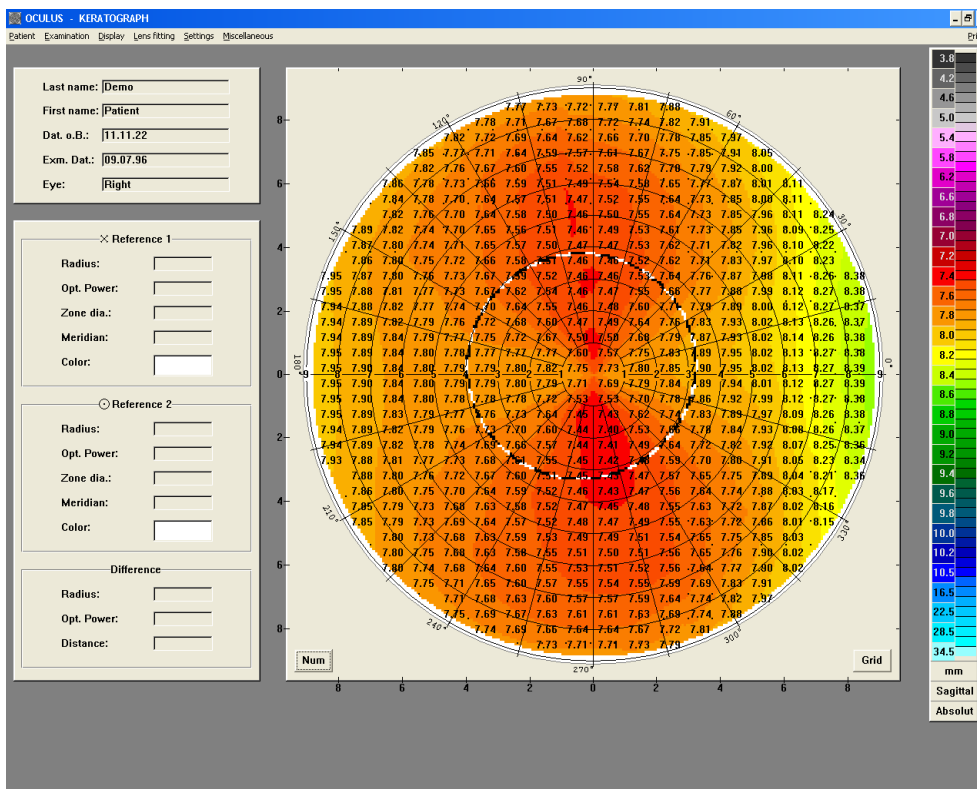
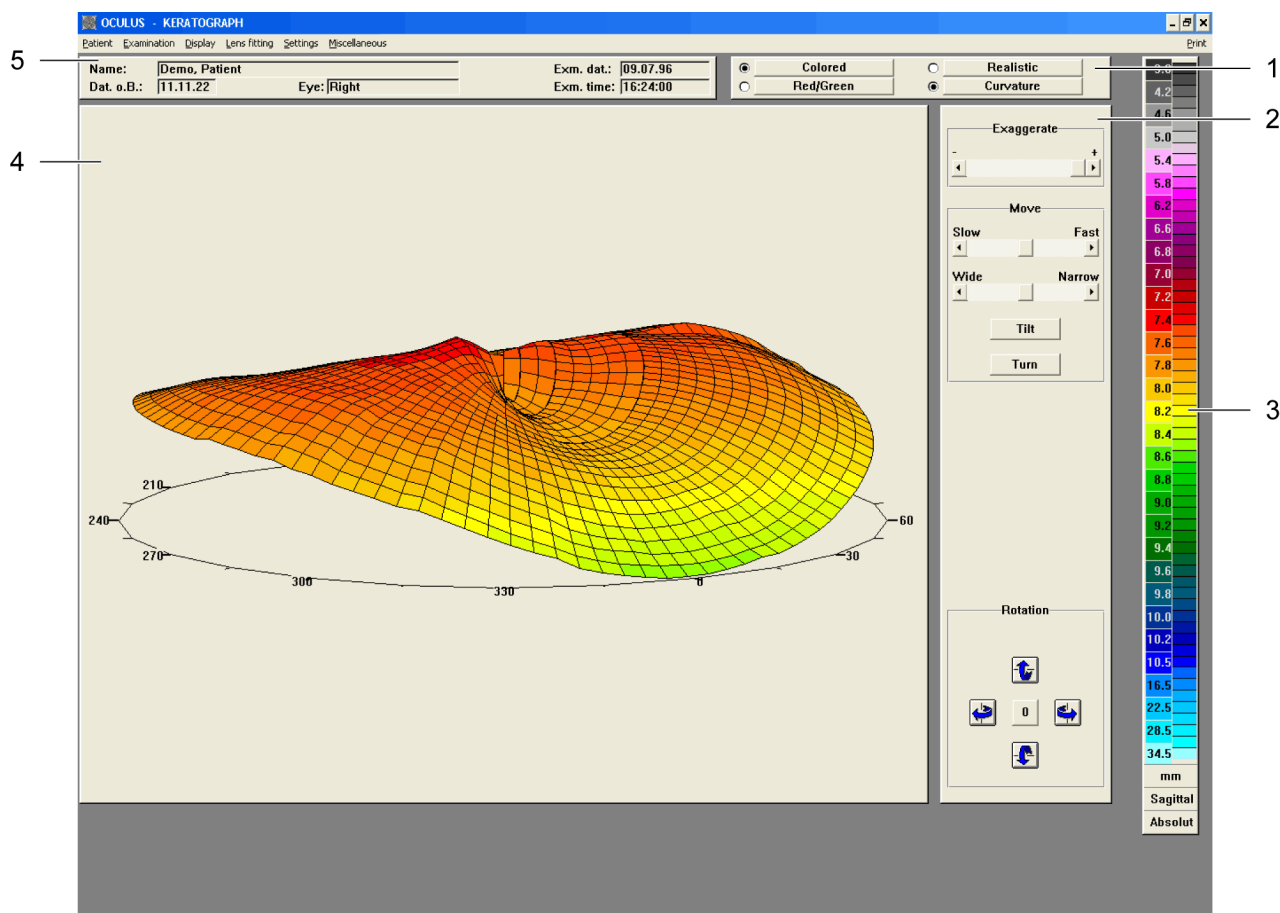


Fig. 3-10: "Color Map (large)" screen with grid and numeric values displayed

3.3 3D display

The program offers the option of outputting the surface of the cornea as a 3D- color map.

- ➔ In the "Display" menu, select the menu item [3D Cornea]. The following tab appears.



- 1 Selection of the type of display
- 2 Adjusting the display
- 3 Color bars

- 4 3D display
- 5 Patient and examination data

Fig. 3-11: Display "3D Cornea"

The geometric ratios of the surface of the cornea can be easily demonstrated to the patient in this map. The patient and examination data are output in the top left section of the screen (5) ([sect. 3.1.1, page 22](#)).

The general mode of presentation can be set using the four options buttons at the top right (1).

- **Colored:** A full color surface map is presented. The color on the surface corresponds with the assignment to the respective radius of curvature (color bar).
- **Red/Green:** The map is shown as a wireframe. If you look at this map through red/green spectacles, you get a truly three-dimensional effect.
- **Realistic:** In this map the actual shape of the cornea is displayed when the [Exaggerate] slider control is slid fully to the left. By sliding the slider control further to the right, the deviations of the measured cornea from the reference shape are shown exaggerated, making it easier for you to diagnose an astigmatism or keratoconus.

- **Curvature:** In this presentation, the height corresponds to the curvature at the respective point. Any differences in curvature of the cornea are therefore more apparent than in the "Realistic" presentation. To enhance this effect even more, you can slide the "Exaggerate" slider control all the way to the right (maximum exaggeration)

Note

The map presented when the "Curvature" option is selected does **not** match the actual course of the cornea. In this presentation a sphere would appear as a flat surface, as the curvature is the same at each point on the surface.



Each of the above-mentioned map types can be rotated to any position using the buttons (2) in the "Rotation" box.

- ➔ Press the arrow buttons in the "Rotation" box. The map is rotated in the respective direction.
- ➔ Press the [0] button to return the map to its original position.

The map can also be moved automatically using the buttons in the [Move] box.

- ➔ Press the [Tilt] or [Turn] button. After calculation of the animation, the map is moved accordingly.
- ➔ Adjust the movement with the slider control. You can make the movement go slower or faster, and can perform the animation over a wider or narrower area.
- ➔ Adjust the exaggeration with the [Exaggerate] slider control.

Thanks to the exaggeration, the curvature of the cornea is shown more pronounced.

3.4 Fourier Analysis

3.4.1 Background Information

Named after the french physicist Jean Baptiste Joseph Fourier (1768-1830), the Fourier Analysis is a mathematical process, which breaks up (decomposes) a periodic function into a number of sine and cosine waves.

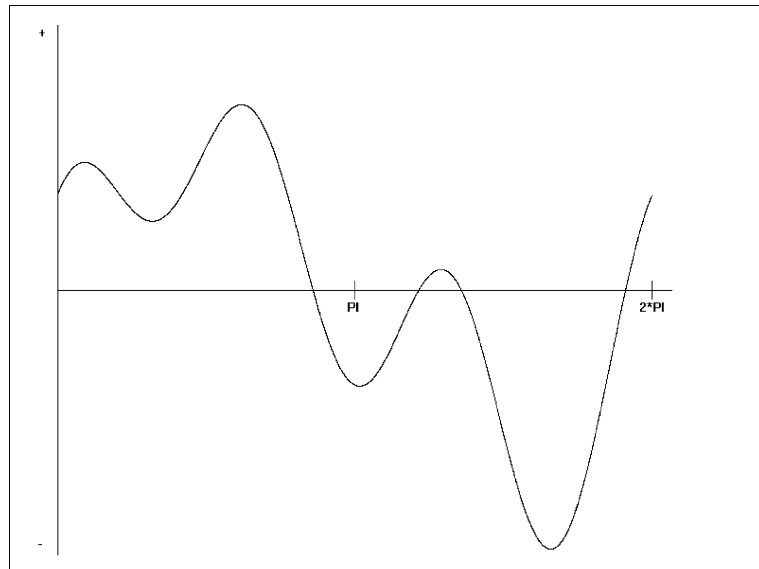


Fig. 3-12: Wave that is to be analyzed

The first basic wave (1st harmonic) is thereby a sine wave with the same period as the wave that is to be analyzed. The 2nd harmonic has half the wave duration (equal to two sine waves), the 3rd harmonic has 1/3 of the wave duration (equal to three sine waves) etc. The addition of all these individual wave components (the so-called Fourier synthesis) results in the original function again.

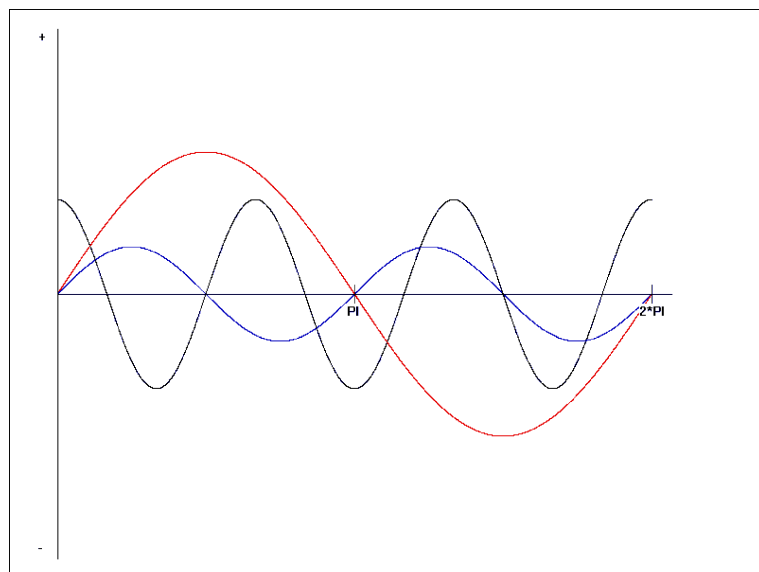
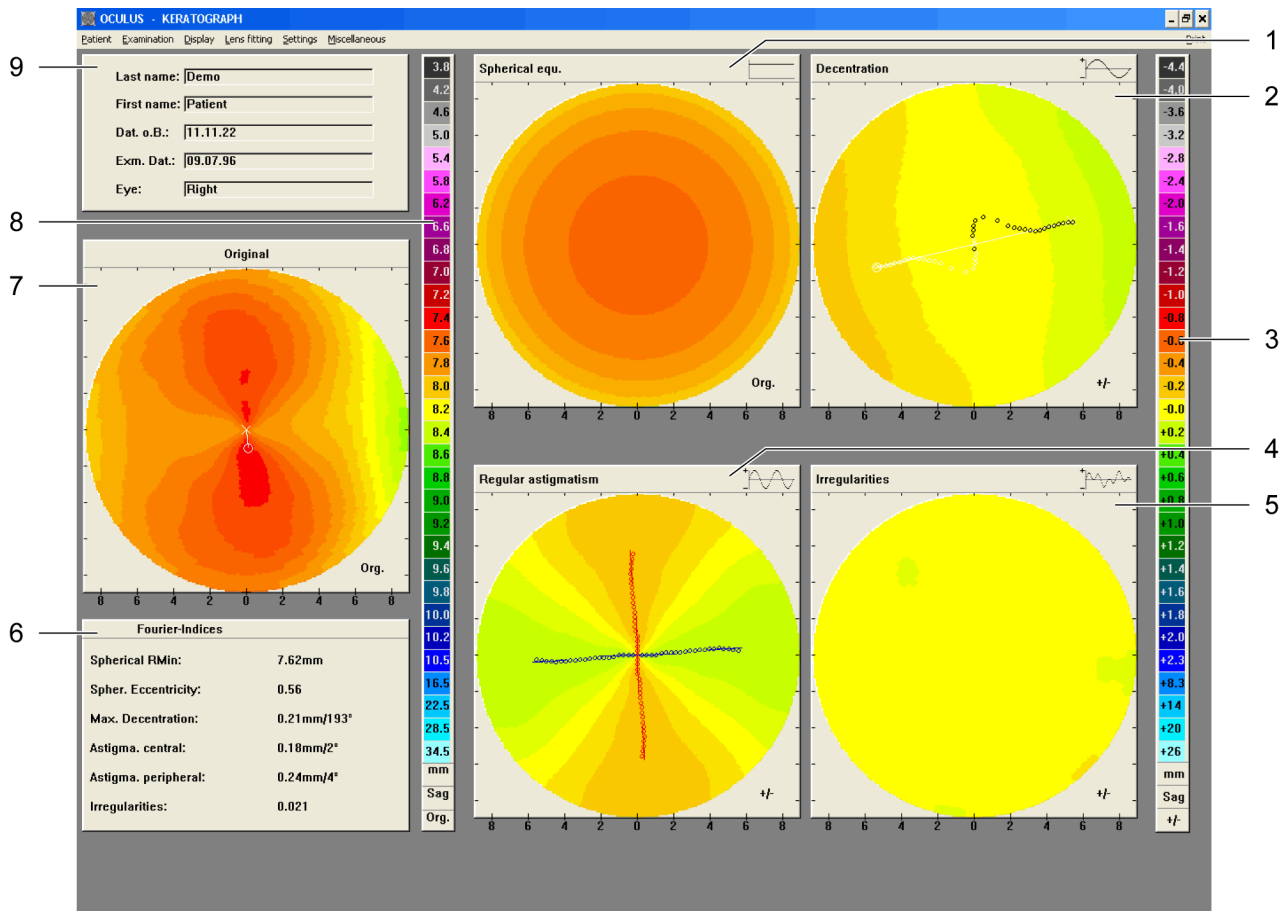


Fig. 3-13: Decomposition into two sine and one cosine wave

The topography map generated by the keratograph can be broken down into individual components using a Fourier analysis. The original image is first divided up into individual concentric rings. The curvature on each ring is then broken up into the individual sine or cosine waves.

- ➔ In the "Display" menu, select the menu item [Fourier Analysis]. The following tab appears.



- 1 Spherical component
- 2 Decentration
- 3 Color bar "relative" (+/-)
- 4 Regular astigmatism
- 5 Irregularities
- 6 Fourier indices
- 7 Original topography map
- 8 Color bar "absolute" (org.)
- 9 Patient and examination data

Fig. 3-14: "Fourier Analysis" display

The patient and examination data are displayed in the top left section (9) of the screen (sect. 3.1.1, page 22). The topography map (7) is displayed below that (sect. 3.1.2, page 23). The individual components of the Fourier Analysis are displayed as color maps in the right hand section of the screen (1, 2, 4 and 5).

3.4.2 Color Maps of the Components

Spherical Component (1)

The arithmetic mean of all radii for each ring (wave component of the 0th order) are shown in this map. This mean value can also be interpreted as the spherical portion of the radii per ring. The eccentricity of the cornea compared to a rotational ellipsoid can be approximated from this.

Guide: For normal eyes, this value is below 0.85.

Decentralization (2)

The wave component of the 1st order is equal to a uniform sine wave, which passes through a minimum and a maximum during a rotation on the respective radius ring. It represents the tilt between the optical axis of the keratograph and the optical vertex of the cornea.



Note

Note that this function only provides relative values, as its arithmetic mean is "zero".

For the wave of each radius ring, the position of the minimum value is shown with a white ring and the position of the maximum value is shown with a black ring. The different axis positions of the decentration on the individual rings are thus easy to identify.

Guide: For normal eyes in the sagittal radius map the maximum barely exceeds 0.43 mm, in the tangential radius map, barely 1.88 mm.

The color map of the decentration can be adjusted so that the spherical component is added. This map gives a clear presentation of the conus position, in which the apex is often easier to identify than in the original image. The setting is made on the "Change settings" screen ([sect. 7.1.15, page 112](#)).

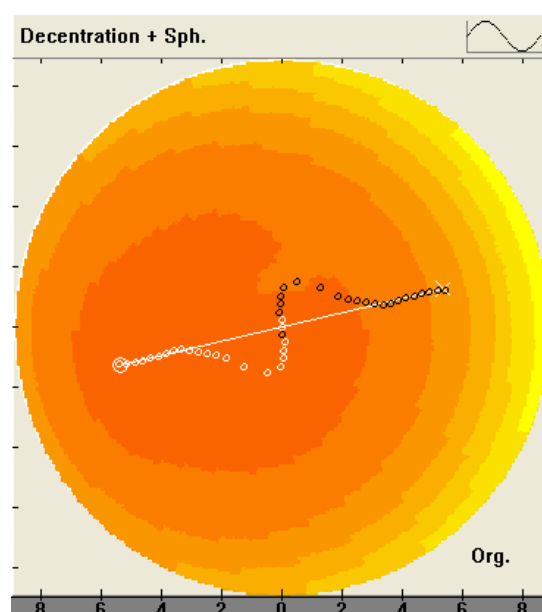


Fig. 3-15: Map of the decentration with added spherical component

Regular Astigmatism (4)

The wave component of the 2nd order is equal to a uniform sine wave at double frequency, which passes through two minimums and two maximums during a rotation on the respective radius ring.

Note

Note that this function too only provides relative values, as its arithmetic mean is also "zero".



For the wave of each radius ring, the position of the minimum value is shown with a red ring and the position of the maximum value is shown with a blue ring. In addition, central and peripheral astigmatism are indicated by red and blue lines. A red line means a steep meridian, a blue line means a flat meridian.

Experience has shown that the amount and axis position of the central astigmatism based on a Fourier Analysis correspond better with the subjective refraction than the measured central radii of the integrated keratometer. The reason for this is that a decentration, or high corneal aberrations (e.g. three- or four wave) affect the amplitude and the axis position of keratometer measurements.

Irregularities (5)

All remaining wave components are added and are shown, in turn, as irregularities in the form of relative values.

Guide: For normal eyes, the mean value of the irregularities in the sagittal radius map is below 0.030 mm, and in the tangential radius map, below 0.141 mm.

An inverse correlation exists between the irregularity and the best possible, corrected visual acuity.

Only those wave components that cannot be corrected by sphere, cylinder or prism are displayed in the "Irregularities" field. If these irregularities are big, the patient will only get good vision with **rigid contact lenses**.

The color map of the irregularities can also be adjusted such that the spherical components are added. Any three or four wave aberration is often easier to identify in this map than in the original one. The setting is made on the "Change settings" screen ([sect. 7.1.15, page 112](#)).

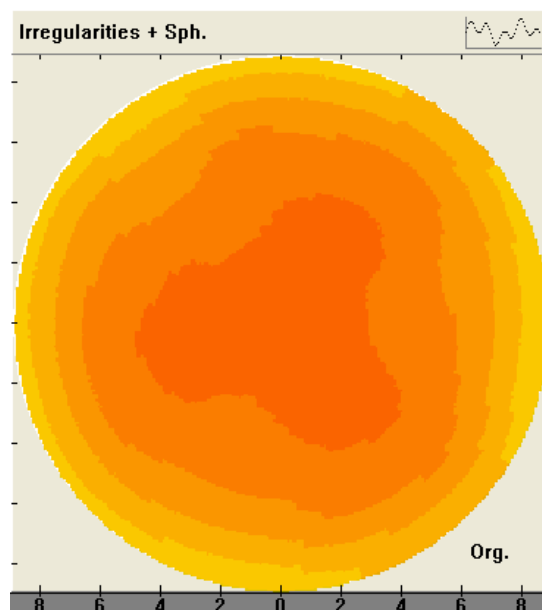


Fig. 3-16: Map of the irregularities with added spherical components



Note

The curvature value at any given point can be displayed in all maps by clicking on that point with the left mouse button.

3.4.3 Display of the Fourier Indices

The Fourier indices are displayed as numeric values at the bottom left (6) of the screen. These provide a quick characterization of the corneal surface.



Note

Pathological values are automatically highlighted in red in the display.

The following individual indices are output:

- **"Spherical RMin:"** Minimum radius of curvature of the spherical component.
- **Spher. Eccentricity:** Corneal eccentricity calculated from the spherical component.



Note

→ Do not confuse this value with the eccentricity at 30° determined with the sagittal radius measuring method.

- **Max. Decentration:** Maximum value and position of the decentration in the "Decentration" map.

- **Astigma. central:** Difference in curvature and axis position of the regular, central astigmatism.
- **Astigma. peripheral:** Difference in curvature and axis position of the regular, peripheral astigmatism.
- **Irregularities:** Mean value of all deviations in the "Irregularities" map.

3.4.4 Color bars

Two color bars are displayed in the Fourier map.

- The left color bar (8) is the same as that shown in the topography map in the overview screen ([sect. 3.1.2, page 23](#)). "Org." is displayed in the last line of this color bar.
- The right color bar (3) represents the relative scale. "+/-" is displayed in the last line of the color bar.

The left color bar applies for the following maps:

- Original and
- Spherical components and
- Decentration and irregularities when the spherical component has been added.

The right color bar applies for the following maps:

- Regular astigmatism and
- Decentration and irregularities when the spherical component has **not** been added

Note

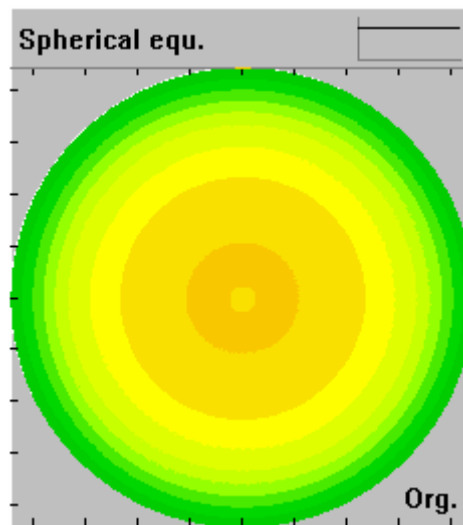
The color bar that applies for the respective map is shown at the bottom right of that map ("Org." or "+/-").



3.4.5 Application Example for Keratoconus

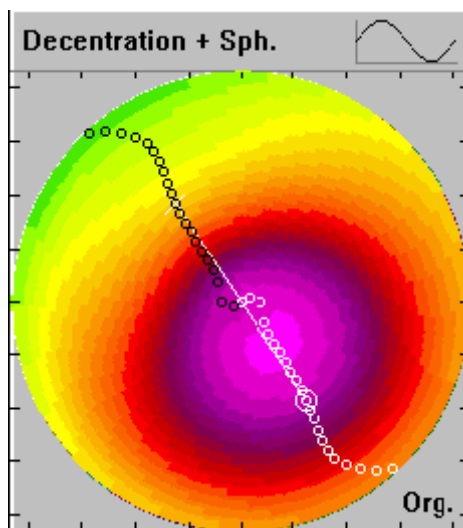
In a patient with keratoconus, the following deviations from maps of healthy eyes can be found to a greater or lesser extent depending on the stage.

Spherical component



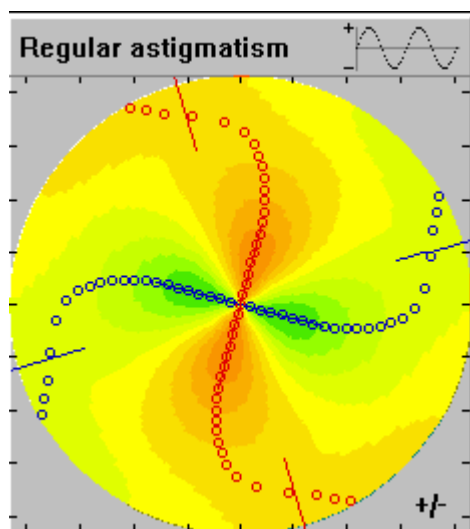
The minimum radius of curvature "Spherical RMin" is steeper and is generally below 6.87 mm in the sagittal radius map, and generally below 6.93 mm in the tangential radius map. The eccentricity value "Spher. Eccentricity" can also exceed the normal value of 0.85. However, these two values are inconsistent and cannot be used alone as an identifying feature for a keratoconus.

Decentration and Spherical Component



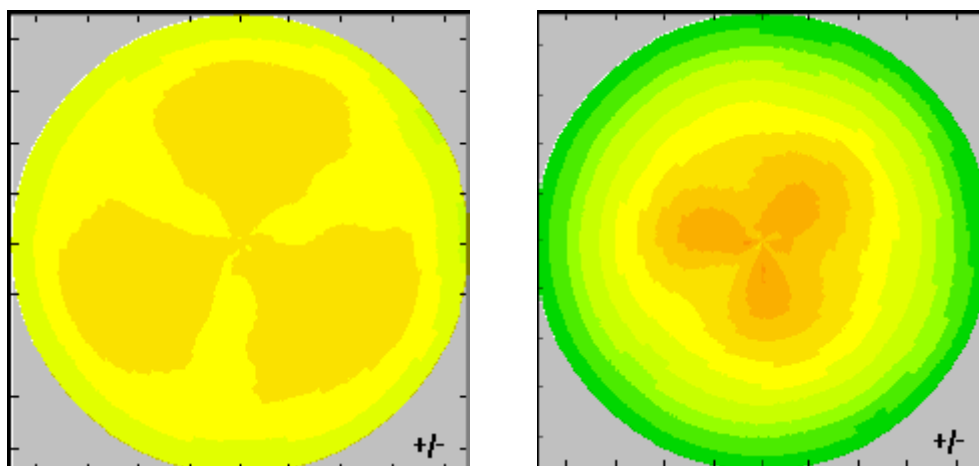
The directional axis of the decentration is generally vertical or vertically sloped according to the apex position of the conus, and is shown very clearly in the decentration and spherical component map. In healthy eyes, the directional axis of decentration is generally horizontal or horizontally sloped.

Regular astigmatism



While with astigmatism, the axis runs in a straight line, with a keratoconus, it often turns from the center towards the periphery and thus takes on a spiral appearance.

Irregularity or Irregularity and Spherical Component



With a keratoconus, three- or four-leaf shapes can often be seen more or less pronounced in the map. These correspond to higher order corneal aberrations, which in Zernike polynomials ([sect. 3.5, page 39](#)), are known as three-wave/trefoil or four-wave/quadrafoil. The combination with the spherical component often makes the shapes even more pronounced.

3.5 Zernike Analysis

3.5.1 General

Zernike polynomials are generally used to describe wavefronts. The following figure shows the passage of a parallel wavefront through a refracting surface L.

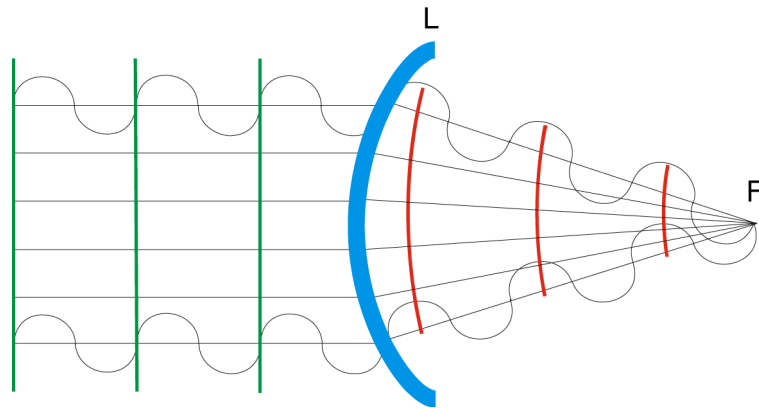


Fig. 3-17: Passage of a parallel wavefront through a refracting surface L.

Each ray of light consists of a sinusoid wave. The positions at which all sinus waves have the same phasing form wavefronts, which move towards the refracting surface on planes vertical to the propagation direction of the light. There, the parallel wavefronts are distorted, ideally to spherical waves, which run directly toward the focal point F (these are symbolized by concentric segments of a circle around F).

However, this ideal case is rarely achieved, because after passing the refracting surface, the real wavefronts show a deviation from the ideal spherical waves (the difference range is indicated by small squares in the following figure).

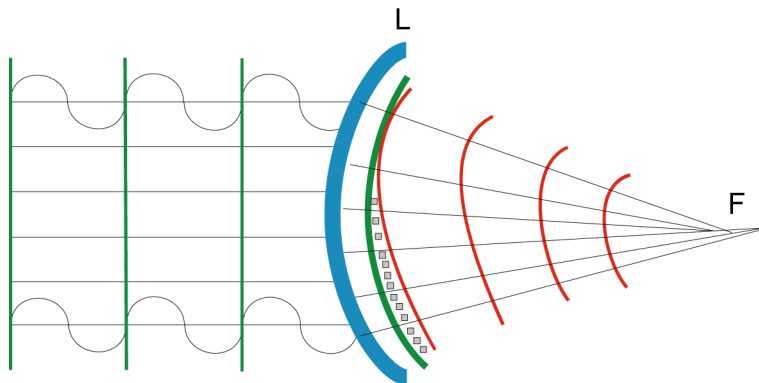


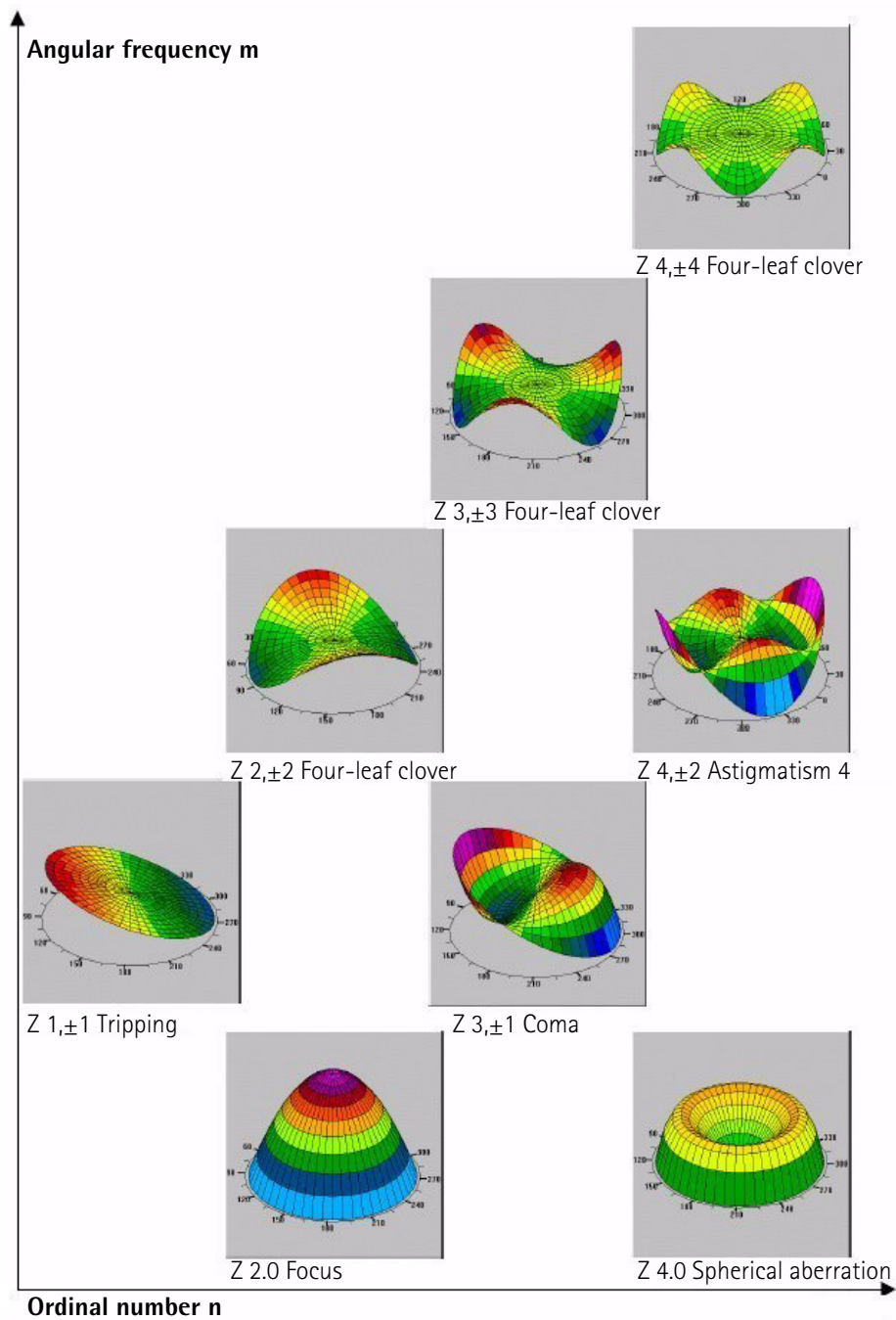
Fig. 3-18: Passage of a real wavefront through a refracting surface L.

The smaller this deviation or aberrations is, the higher the quality of the refractive system is, whether it be a telescope, a microscope, the cornea or the refractive media of the human eye in general.

The Dutch physicist, Frits Zernike (1888-1966), succeeded in mathematically illustrating the deviation of the real wavefront from the ideal one using a sum of polynomials. Each polynomial thereby bears the same name as the aberration it reflects (e.g. astigmatism, coma or spherical aberration). Zernike polynomials are also referred to as circle polynomials, because they relate to a standardized unit circle and are shown with the help of polar coordinates.

Mathematically, the individual Zernike polynomials are a circular surface characterized by polar coordinates with a power series in radial direction ρ and a Fourier-like series in the direction of the angle θ . In the general equation $Z_{n,\pm m}$, n represents the ordinal number of the polynomial in radial direction and m equals the frequency of the angle θ per 360° . Polynomials in which n is an even number and $m=0$ are always rotationally symmetric, all others are angle-dependent.

3.5.2 Summary of the Most Important Zernike Polynomials



3.5.3 Definitions of the First Zernike Polynomials

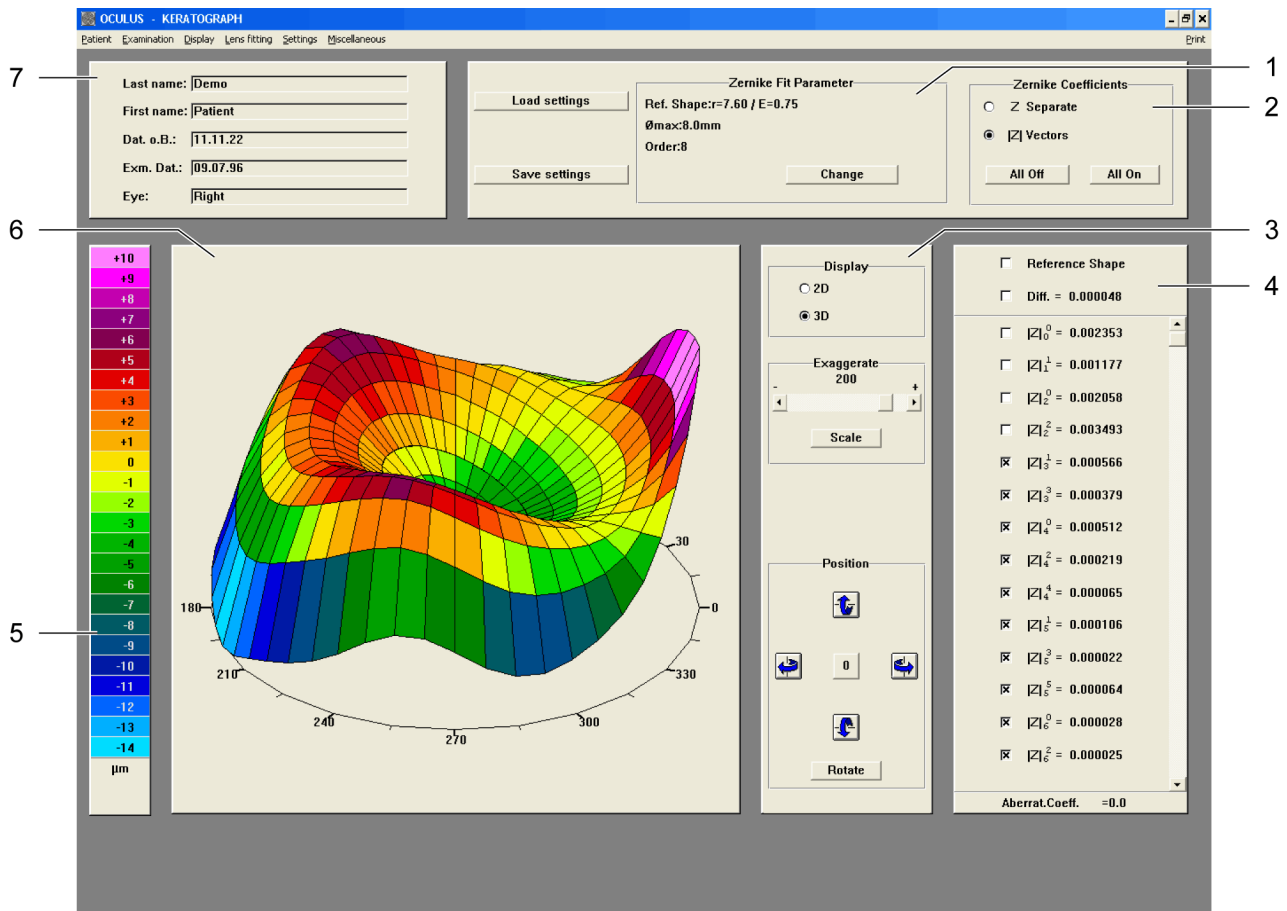
Zernike polynomials enable mapping errors to be described in the form of mathematical polynomials. The individual polynomials each provide the name of the associated mapping error.

- **Z 0,0:** Elevation constant, central height of the surface
- **Z 1,±1:** Tipping (+1 in x direction, -1 in y direction)
- **Z 2,0:** Focus, respective surface in the form of a conical section)
- **Z 2,±2:** Astigmatism
- **Z 3,±1:** Coma
- **Z 3,±3:** Three-leaf clover
- **Z 4,0:** Spherical aberration
- **Z 4,±2:** Category 4 astigmatism
- **Z 4,±4:** Four-leaf clover
- **Z 5,±1:** Category 5 coma
- **Z 5,±3:** Category 5 three-leaf clover
- **Z 5,±5:** Five-leaf clover
- **Z 6,0:** Category 6 spherical aberration
- **Z 6,±2:** Category 6 astigmatism
- **Z 6,±4:** Category 6 four-leaf clover
- **Z 6,±6:** Six-leaf clover

The keratograph performs a Zernike Analysis based on the measured height data for the front surface of the cornea.

➔ In the "Display" menu, select the menu item [Zernike analysis].

The coefficients of the individual polynomials are calculated and output in plain text as well in a graphical display.



- 1 Zernike Fit Parameter
- 2 Zernike coefficient
- 3 Adjusting the display
- 4 Zernike coefficient
- 5 Color bars
- 6 3D- or 2D display
- 7 Patient and examination data

Fig. 3-19: "Zernike analysis" display

3.5.4 General settings

Customizing the Settings

The parameters used to make the Zernike analysis can be adjusted.

- ➔ Click on the [Change] button in the "Zernike Fit Parameter" box (1) with the left mouse button. The following dialog appears:

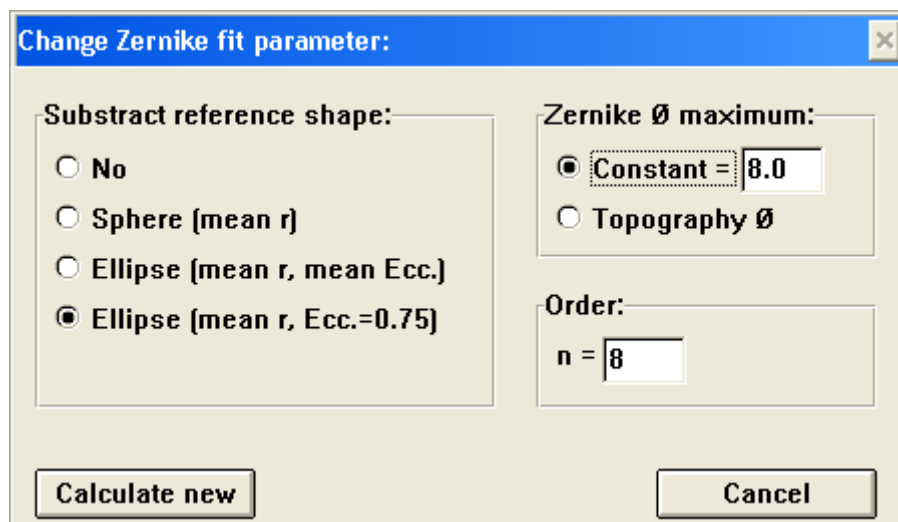


Fig. 3-20: General settings for the Zernike analysis

- In the "Subtract reference shape" box, select the reference shape that is to be subtracted from the measured height data. The following reference shapes are available for selection:
 - **Sphere (mean r):** Sphere with the mean central radius of the measurement.
 - **Ellipse (mean r, mean Ecc.):** Ellipse with the mean central radius and mean eccentricity of the measurement.
 - **Ellipse (mean r, Ecc.=0,75):** Ellipse with the mean central radius and an eccentricity of 0.75.
- In the "Zernike Ø maximum" box, enter the diameter for which the Zernike analysis is to be done. You can select from the following options:
 - **constant =:** Enter the desired diameter as a numeric value here. Typically, a value of 8.0 mm is used.
 - **Topography Ø:** The Zernike analysis is done for the total measured corneal area.
- Enter the maximum order number of the Zernike polynomial that is to be calculated into the field "n =" in the "Order:" box.
- Press the button [Calculate new] to make the analysis with the new parameters.

Saving and Loading the Settings

- To save the present settings, press the button [Save settings] on the "Zernike Analysis" screen. These settings are then automatically loaded and used for the analysis the next time the "Zernike Analysis" screen is opened.
- If you have changed the settings for another analysis in the meantime, press the button [Load settings] to manually reload the settings that were last saved.

3.5.5 Zernike coefficient display

The coefficients are displayed as a simple list in the right hand section of the screen (3).

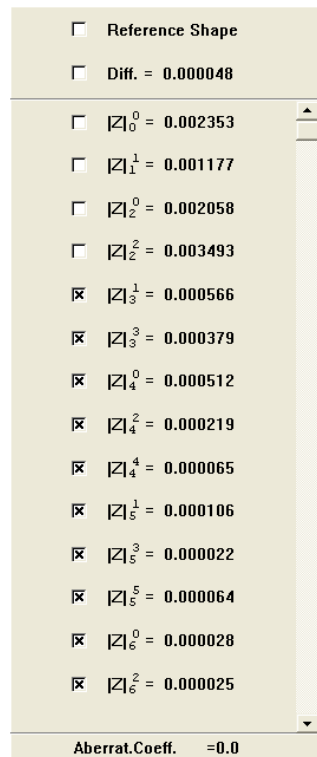


Fig. 3-21: Zernike coefficient display

The individual coefficients are displayed below each other.

→ Activate the checkbox in front of the coefficients which should be considered for the graphical display (Fig. 3.5.6, page 46).

The coefficients can be displayed as individual values or as vectors. The vector display summarizes the coefficients of polynomials which cause the same mapping errors.

Example: The astigmatism is composed of both of the polynomials $Z_{2,2}$ and $Z_{2,-2}$. These differ only in the trigonometric component (cosine or sine).

Instead of both individual values being shown, the vector display indicates an amount and the associated angle. The amount is a measurement of the section of the respective polynomial, the angle is recognizable in the 3D display.

"Normal values" are stored in the program for the Zernike coefficient vector values. Any coefficients that deviate from these normal values are shown in red. The condition for this is that you have selected the following general settings (sect. 3.5.4, page 43):

- **Reference shape:** Ellipse Ecc=0,75
- **Order:** n = 8
- **Zernike Ø maximum:** constant = 8,0 mm

A keratoconus is frequently recognizable already at lower levels of pronouncement in this way. Furthermore, this functions makes it easier to detect the apex position of the keratoconus.

The program generally also calculates the so-called **aberration coefficient** using the Zernike coefficients. In case a coefficient does not deviate from the normal value, then the aberration coefficient has a value of "0". If the aberration coefficient has a value greater than "1", then there are oscillation components on the corneal surface which are atypical and are possibly the cause of reduced optical quality.

3.5.6 Graphical display

The polynomials are also displayed graphically in the form of height data in the left hand section of the screen (6).

To display the height data, a rotationally symmetrical ellipse with an eccentricity of 0.75 should preferably be used as the reference shape, as this comes very close to the actual shape of the cornea. The graphical display of individual polynomials and coefficients can be interpreted as a deviation from this ellipsoid.

Basically, the selected polynomials can be output in a 2D display or a 3D display. First, select the Zernike polynomials which should be displayed.

- ➔ Press the [All on] or [All off] button to activate/deactivate all polynomials.
- ➔ After preselection in this way or in general, the individual polynomials can be selected/deselected via the associated checkbox in front of the coefficient.



Note

The graphical display is updated immediately by selecting/deselecting polynomials, but **not** scaled automatically. The influence of the corresponding coefficients can be better approximated in this way.

- ➔ Activate the [Reference shape] checkbox as required. When this is activated, the height data of the reference shape are added to the polynomial data. A realistic presentation is thus possible even when using a reference shape.
- ➔ If you deactivate the [Reference shape] checkbox, the position and height of the apex are also output. In the 2D presentation, this point is marked with a black cross.



Note

The height of the apex represents a measure for the severity of the keratoconus. The more advanced the keratoconus, the greater this height will usually be.

- ➔ Activate the [Diff.] checkbox as required. If this is activated, the deviation from the original data are added to the height data. This deviation occurs because the used polynomials are **fitted** to the original data as well as possible, but a deviation still exists. The higher the order of the used polynomial, the better a fit can be achieved and the lower the deviation will be.



Note

The standard deviation of the original data to the Zernike polynomials is shown after the checkbox, in the field "Diff =".

Now select the display form in the second step.

- ➔ Select the option "2D" for the 2D display.

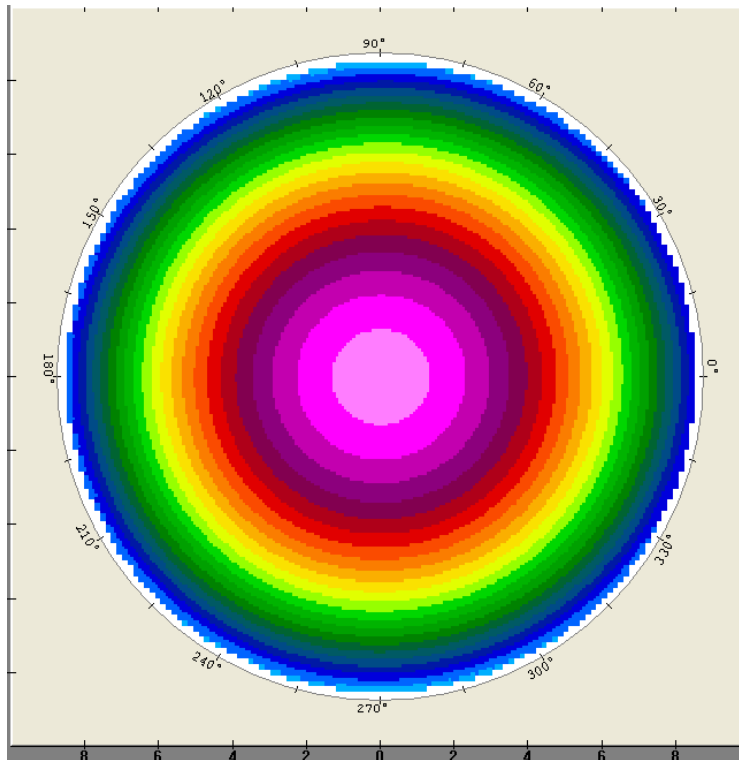


Fig. 3-22: Zernike display in "2D"

→ Alternatively, select the option "3D" for the 3D display.

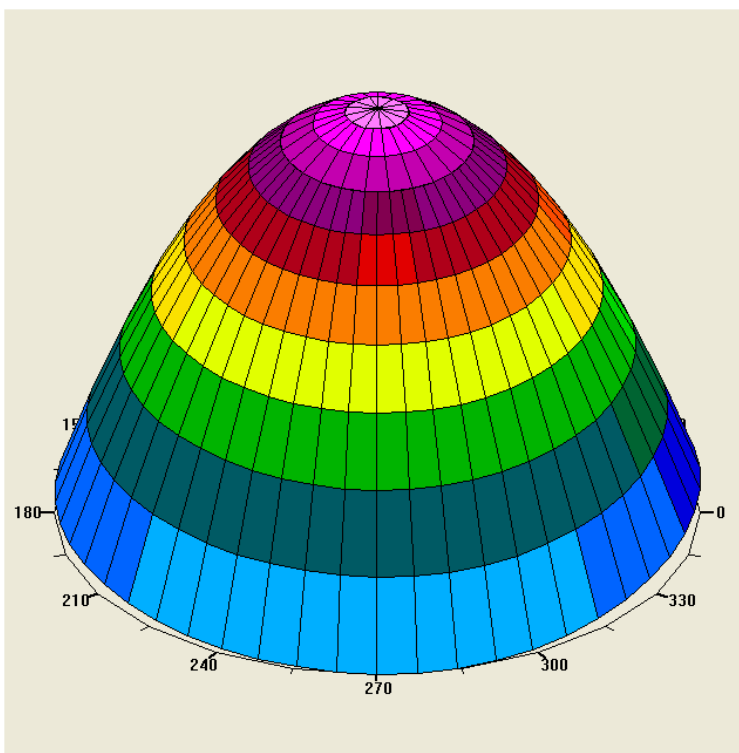


Fig. 3-23: Zernike display in "3D"

→ Press the [Scale] button for an optimal color map.

Notes about 2D display

- Click with the left mouse button in the 2D display to show the current elevation at the relative location.

Notes about 3D display

- Move the slider "Exaggerate" to the right to exaggerate the 3D display. Press the [Scale] button again to rescale the graphic to the optimum.
- Just like with the 3D topography map, by clicking on the arrow buttons, you can rotate the 3D Zernike polynomial map and then return it to its original position by pressing the [0] button ([sect. 3.3, page 29](#)).
- The 3D map provides a clear overall picture, but the height values at certain corneal positions cannot be determined very well. It is better to use the 2D map for this purpose.

Diagnosing a Keratoconus

- Select the following settings for early detection of a less pronounced keratoconus:
 - **Reference shape:** Ellipse Ecc=0,75
 - **Zernike coefficients:** Activate all polynomials with the exception of the lower orders Z 0.0, Z 1.1, Z 2.0 and Z 2.2 and display them as vector values.

The apex position of the keratoconus can this be identified more easily. Experience has shown that the normal map of the sagittal radii (left) can be misleading when it comes to the actual position of the apex. In the Zernike 2D map (center) and in the simulated fluo image (right), the apex position is easier to see, as elevation values are used here for the mapping purposes.

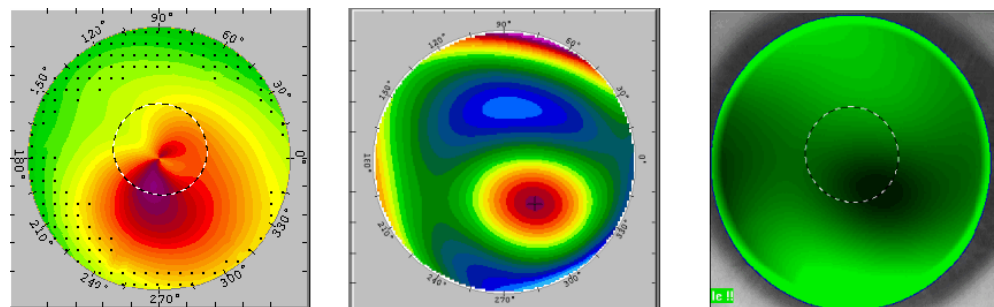


Fig. 3-24: Comparison of sagittal radii, Zernike 2D and fluo-image maps



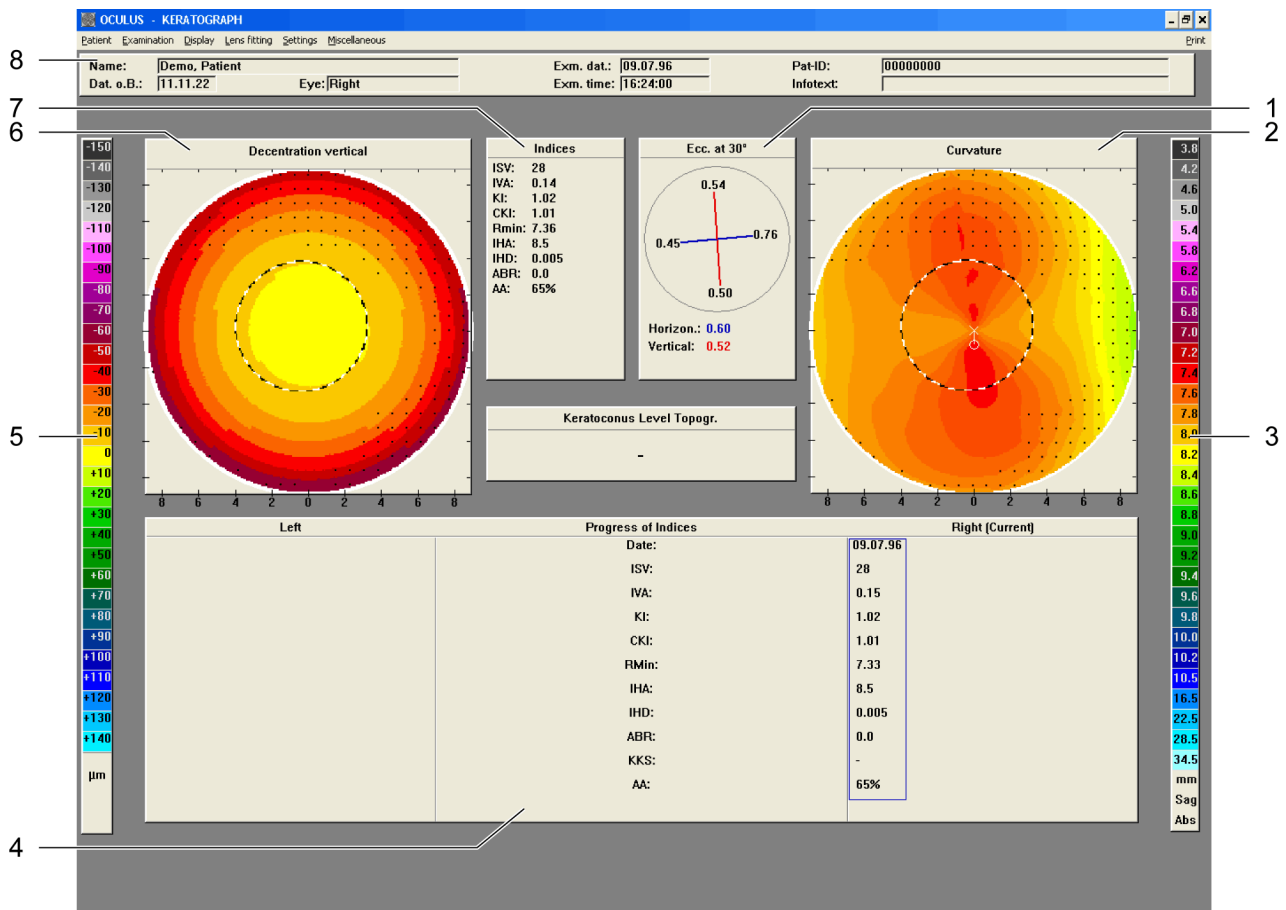
Note

As the disease progresses, the position of a keratoconus apex generally moves temporally/ downwards.

3.6 Indices

On this screen, various indices in particular are output, which reduce the high quantity of keratograph measurement data to just a few characteristic values. A statement about the shape of the surface of the cornea can be made with the help of these indices.

→ In the "Display" menu, select the menu item [Indices]. The following tab appears.



- | | |
|-----------------------------------|---|
| 1 Corneal eccentricity | 5 Color bar for the vertical decentration |
| 2 Curvature display | 6 Color map "Vertical decentration" |
| 3 Color bar for the curvature map | 7 Indices |
| 4 Progress of indices | 8 Patient and examination data |

Fig. 3-25: "Indices" display

The keratograph used the following data for index calculation:

- Curvature data
- Elevation
- Data from the Fourier analysis
- Data from the Zernike analysis

The comprehensive use of all relevant corneal data enables different abnormalities to be detected at an early stage.

The patient and examination data (sect. 3.1.1, page 22) are displayed in the top section of the screen (8). The following are also displayed there:

- **Pat-ID:** Patient ID, as entered in the patient data management system.

- **Infotext:** Infotext, as entered in the scaled down camera image in the overview screen ([sect. 3.1.5, page 25](#)).

The vertical decentration based on the Fourier analysis of the height data is output at the top left (6), below the patient and examination data ([sect. 3.4.2, page 33](#)).

For normal and astigmatic eyes, and for very central keratoconus, still fully closed rings are visible in this map, which open up more and more as the transition to keratoconus due to decentration progresses, until they ultimately take on the shape of an inverted omega in the center.

Examples

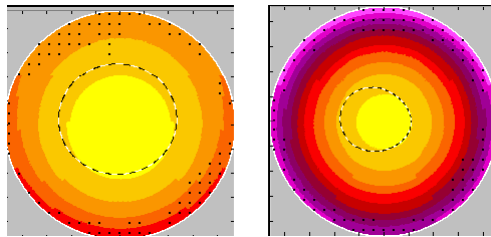


Fig. 3-26: Normal eye (left) and astigmatic eye (right)

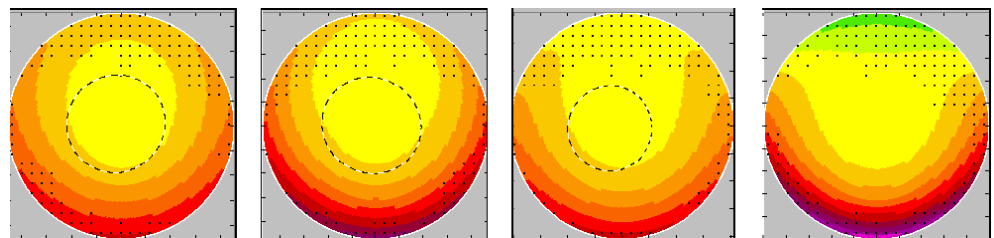


Fig. 3-27: Potential KC (left and 2nd from left) and beginning of a KC (2nd from right and right)

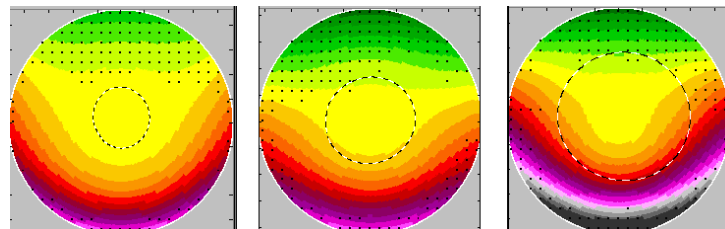


Fig. 3-28: KC stage 1 (left), KC stage 1-2 (center) and KC stage 2 (right)

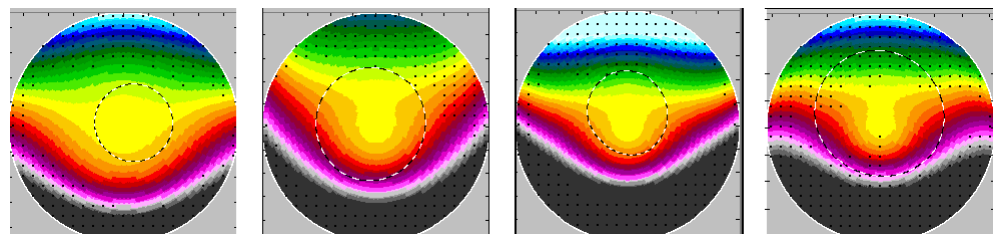


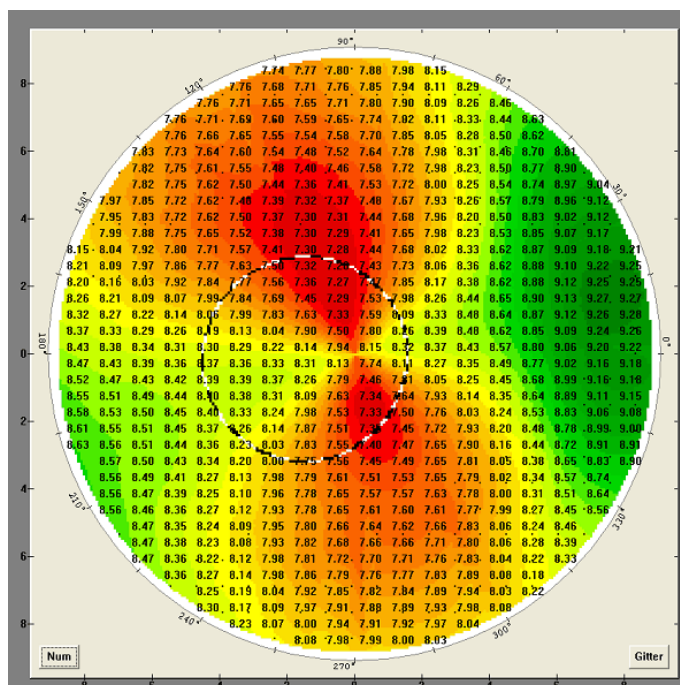
Fig. 3-29: KC stage 2-3 (left), KC stage 3 (2nd from left), KC stage 3-4 (2nd from right) and KC stage 4 (right)

Just like on the overview screen, the curvature map (2) is displayed below the patient and examination data, on the right hand side ([sect. 3.1.2, page 23](#)).

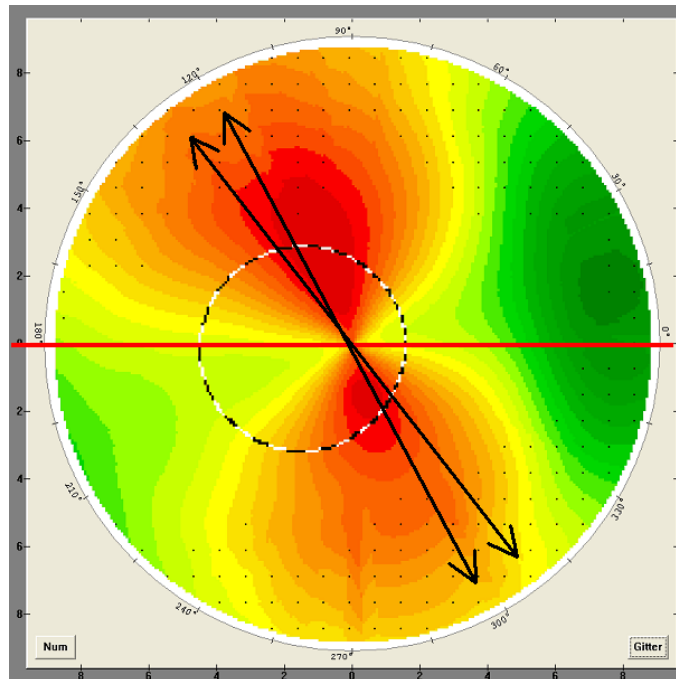
3.6.1 Indices

The following indices are output (7):

- **ISV:** Index of Surface Variance. Standard deviation of the sagittal radii of the measured eye from the mean value (mean sagittal radius). The ISV is elevated for all irregularities of the corneal surface (scars, astigmatism, deformations caused by contact lenses, keratoconus, etc.).

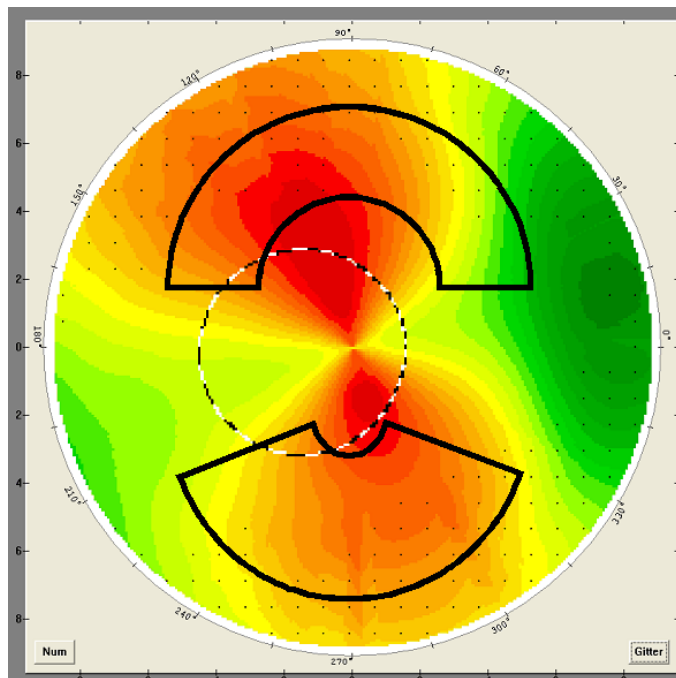


- **IVA:** Index of Vertical Asymmetry. The IVA is the mean value of all differences and represent a measure for the symmetry of the corneal radii relative to the horizontal meridian as an axis of reflection. The difference of the sagittal radius of each point in the top segment is generated with the sagittal radius of the point offset by 180° in the bottom segment. The IVA is elevated for skewed astigmatism axes, for keratoconus or limbus ecstasia.



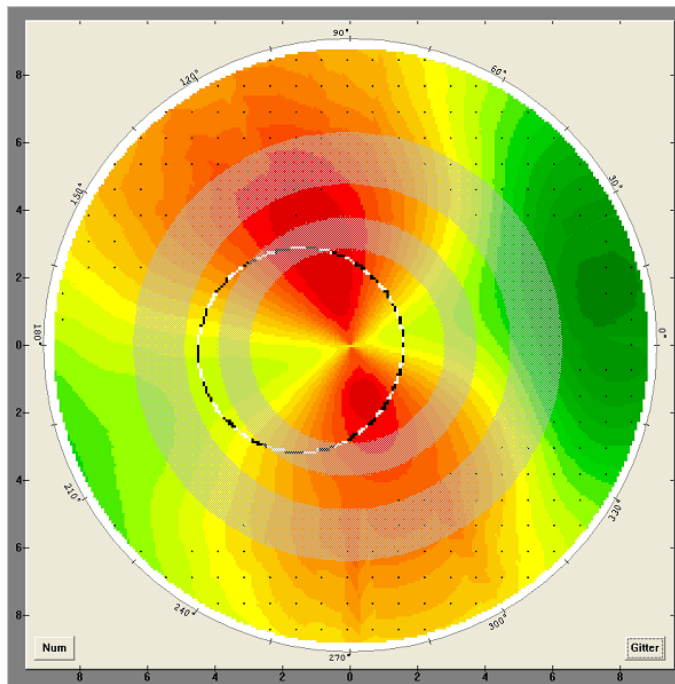
- **KI:** Keratoconus index The KI is the ratio of the sagittal radii mean values in the top and in the bottom segment. The KI is elevated for keratoconi in particular.

$$I = \frac{r_{\text{sagittal}} (\text{Median value top})}{r_{\text{sagittal}} (\text{Median value bottom})}$$

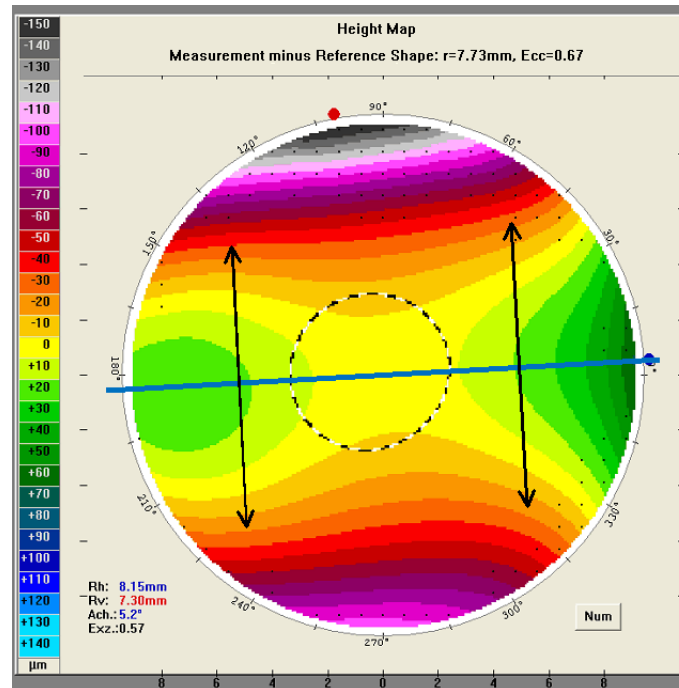


- **CKI:** Center Keratokonius-Index. Similar to the KI, the CKI is the ratio of the sagittal radii mean values in the central and in the peripheral ring The CKI is especially increased for central keratoconi.

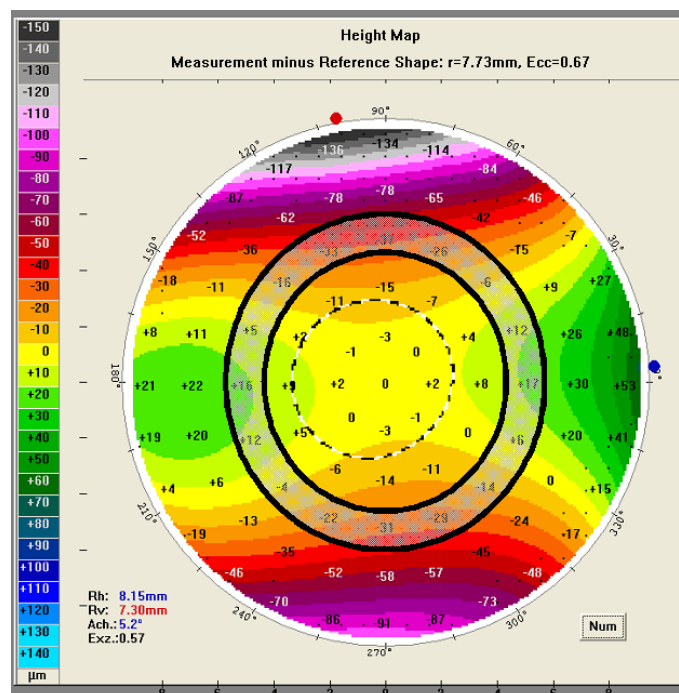
$$KI = \frac{r_{\text{sagittal (Median value periphery ring)}}}{r_{\text{sagittal (Median value central ring)}}}$$



- **Rmin:** The Rmin is the smallest sagittal curvature radius in the entire range of measurement. The Rmin is low for keratoconus.
- **IHA:** Index of Height Asymmetry. The IHA is a measure for the symmetry of the height values relative to the horizontal meridian as the axis of reflection. Each point of the top area is compared with a point mirrored on the axis of reflection. The mean difference of the absolute height values is generated, without generating the modulus. The IHA is sometimes more sensitive than the IVA.



- **IHD:** Index of Height Decentration. The IHD is obtained from the Fourier analysis of height values and reflects their decentration in vertical direction. The amount of the prismatic component is determined on a ring with a radius of 3 mm in the absolute height data. The IHD is elevated in cases of keratoconus.



- **ABR:** Aberration coefficient. The ABR is calculated from the Zernike analysis. If no abnormal corneal aberrations are present, then the $\text{ABR} = 0.0$, otherwise the $\text{ABR} = 1.0$ or higher, depending on the severity of the aberrations.
- **KKS:** Keratokonius-Stadium. The KKS is based on topometric measurements, but follows the clinical findings of Amsler's classical staging schema.
- **AA:** Analysed Area. The AA gives the area of the corneal surface actually measured (and not interpolated) as a percentage of the total measuring field.

The device compares the measured values with the mean values and standard deviations of a normal population. If the 2.5 times the standard deviation is exceeded, the measurements are deemed "abnormal" and are highlighted in yellow. Pathological values, which exceed 3x the standard deviation, are marked in red.

- Click the mouse pointer in the "Indices" field. An information window appears on the screen showing the meanings of the index designations (ISV, IVA etc.).

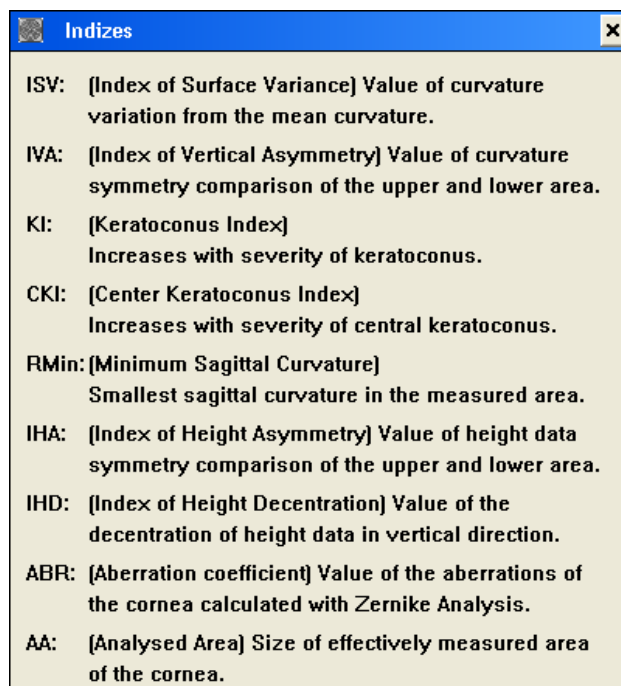


Fig. 3-30: Indices information window

The following limits apply:

Index	Abnormal (Yellow)	Pathological (Red)
ISV	≥ 37	≥ 41
IVA	≥ 0.28	≥ 0.32
KI	> 1.06	> 1.06
CKI	≥ 1.03	≥ 1.03
Rmin	< 6.71	< 6.71
IHA	≥ 19	> 21
IHD	≥ 0.014	≥ 0.016
ABR	≥ 1	≥ 1

3.6.2 Progress of indices

If the individual examinations have already been calculated in the past, all previously determined indices are listed for both eyes in the bottom section of the screen (4). The indices of old and new examinations of both eyes can thus be directly compared at a glance. If more than five examinations per eye are available, a Windows slider control appears

with which to examinations that are to be displayed can be selected. The presently loaded measurement is marked with a blue border.



Note

- Double-click on the desired examination in the progress of indices to directly load the corresponding examination.

3.6.3 Presentation of the Corneal Eccentricity

The corneal eccentricity at 30° is displayed graphically in top center section of the screen (1). The axis position of the central radii is taken into account. The red axis shows the steeper meridian, the blue one the flatter meridian. Here too, red highlighted numbers indicate pathological values. The mean eccentricities in the two main meridians are displayed below the graphic display of the eccentricity.

3.6.4 Topographic Classification

The stage of keratoconus development is determined from the combination of several indices ([sect. 3.6.1, page 50](#)). In addition to the stages, attributes such as "possible" may also be displayed here.

Classification has been adjusted to the classical Amsler or Muckenhirn stadia as well as possible. Nevertheless, always bear in mind that the case is topography-based and not a clinical classification.

- Klick in the field "Keratoconus Level Topogr." to display a table listing the five levels of keratoconus developed by the company OCULUS along with the corresponding clinical features.

Classification of stages of Keratoconus using Videokeratometry							
	VA with glasses	VA with C.Lens	Cor.Indices ISV	KI	Eccentricity in 30°	RMin	Cornea
Pre-stage (early signs)	20/20 to 20/15	20/20 to 20/15	<30	1.04 to 1.07	All four values are normal	7.8 to 6.7	No clear light or shadow movement. Hint of scissors effect.
Level 1	20/25 to 20/15	20/20	30 to 55	1.07 to 1.15	Sometimes one value is abnormal	7.5 to 6.5	Distorted retinoscopic reflex. Scissors effect. Severe placido ring distortion.
Level 2	20/60 to 20/20	20/30 to 20/20	55 to 90	1.10 to 1.25	Often one value is abnormal	6.9 to 5.3	Clear scissors effect, retinoscopy is difficult to perform.
Level 3	20/125 to 20/30	20/40 to 20/20	90 to 150	1.15 to 1.45	At least one value is abnormal	6.6 to 4.8	Distinct scissors effect, retinoscopy is nearly impossible to perform.
Level 4	<20/400 to 20/100	20/100 to 20/40	>150	>1.50	At least one value is abnormal	<5 or not measured	Retinoscopy is impossible to perform.

Remarks:

- Pre-stage (early signs): The diagnosis of the pre-stage of Keratoconus is always based on clinical criteria such as a change in power and the axis of the astigmatism, fluctuating refraction values, conspicuous changes in retinoscopy and corneal shadows during observation with the direct ophthalmoscope. Videokeratometry provides supplementary information, but a diagnosis can not be based solely on the results. Corneal tear film irregularities and fixation problems can yield similar images, without the presence of a true Keratoconus.
- This classification was adapted from the classical Amsler- and Muckenhirn standards. It is a topography based graduation and not a clinical one.
- ISV = Index of surface variance KI = Keratoconus index Rmin = minimum value of the curvature of the cornea
- Eccentricity in 30° refers to the four measuring values nasal, temporal, superior and inferior.
- If visual acuity of 20/25 to 20/20 is achieved with a spectacle correction, contact lenses are not necessarily indicated.
- Munson-sign: The cornea bulges forward. The conical shape is easily recognized in profile, particularly by the acute bulge observed at the lower lid when the patient looks down.

Fig. 3-31: Levels of keratoconus

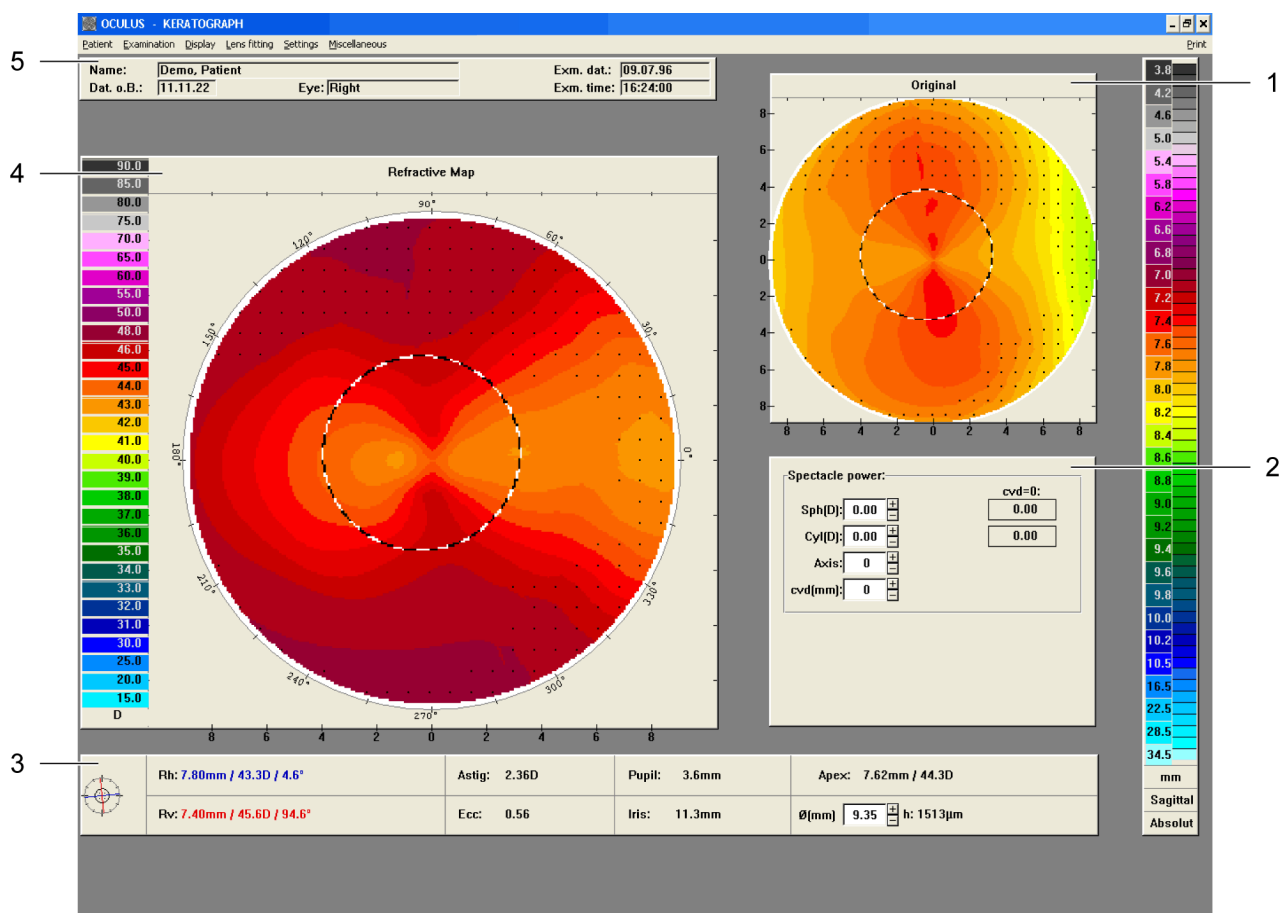
Note

Sole diagnosis of a keratoconus (above all for incipient cases) without including all clinical facts can lead to a misdiagnosis, since irregularities of the mucus layer, irregularities of the cornea, or fixation problems can also provide similar images.



3.7 Refractive map

→ In the "Display" menu, select the menu item [Refractive map].



1 Original topography map
2 Spectacle power
3 Data fields
4 Refractive map with color bars
5 Patient and examination data

Fig. 3-32: "Refractive display" display

This presentation is especially suited for viewing measurements prior to and after treatments with an Excimer laser. The following information is displayed on the screen for this purpose:

- Patient and examination data ([sect. 3.1.1, page 22](#))
- Standard topography map ([sect. 3.1.2, page 23](#))
- Refractive topography map ([sect. 3.7.1, page 58](#))
- Pupil diameter in mm ([sect. 3.7.2, page 59](#))
- The patient's power values at the time of the measurement ([sect. 3.7.3, page 60](#))

3.7.1 Refractive display

This display (4) enables an evaluation of the optical effect of the cornea anterior surface. The focal distance is specified with Snell's law for this (whereby the spherical aberration is considered) and graphically displayed. The difference of the curvature display is clear if the topographical display is compared to a sphere. In the **Curvature display**, only one color is displayed, since the curvature of a ball is the same across its surface. In the **Re-**

fractive display the refractive power becomes larger at the periphery, since the focal distance of the outer region does not match with that of the central region due to the spherical aberration.

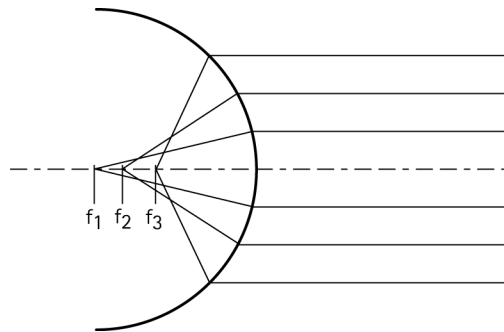


Fig. 3-33: Snell's law

- ➔ Click in the curvature map or in the refractive map. The curvature value and the corresponding refractive power at that location are displayed.

3.7.2 Data fields

The following values are displayed in the data fields (3) below the refractive map:

- **Rh:** Central horizontal radius of curvature in mm and diopters and its axis position.
- **Rv:** Central vertical radius of curvature in mm and diopters and its axis position.

Note

On the "Change settings" screen ([sect. 7.1.6, page 108](#)), you can select whether the horizontal and the vertical radius of curvature or the flat and the steep radius of curvature are to be displayed.



- **Astig:** Astigmatism in the center in diopters
- **Ecc.:** Mean eccentricity of the cornea.
- **Pupil dia:** Pupil diameter in mm.
- **Iris:** Iris diameter in mm.
- **Apex:** Radius in mm and dpt.
- **Ø, h:** Difference in height between the apex point and a height value on the cornea in a changeable diameter around the apex. The height is calculated on the horizontal meridian of the astigmatism with the weighted mean value using the following equation.

$$h = \frac{2 \cdot \text{Temp.} + 1 \cdot \text{Nasal}}{3}$$

- ➔ Change the diameter by pressing the [+] or the [-] button accordingly, or enter the diameter directly into the field.

**Note**

- The determined height values can be used for fitting Ortho-K lenses.

3.7.3 Spectacle power

The patient's refractive values can be entered into the individual fields in the "Spectacle power" box (2).

- **Sph:** Sphere
- **Cyl:** Cylinder (always negative)
- **Axis:** Cylinder axis
- **cvd:** Corneal vertex distance

The corneal vertex power (cvd = 0) is calculated from these values and is displayed.

- Enter the patient's spectacle power values. If you change these, a confirmation dialog box appears.

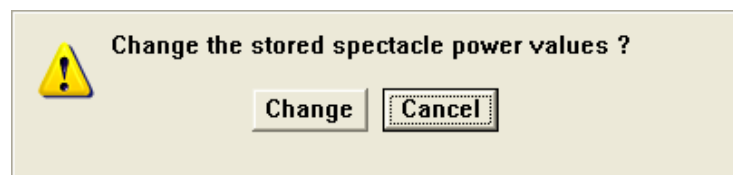
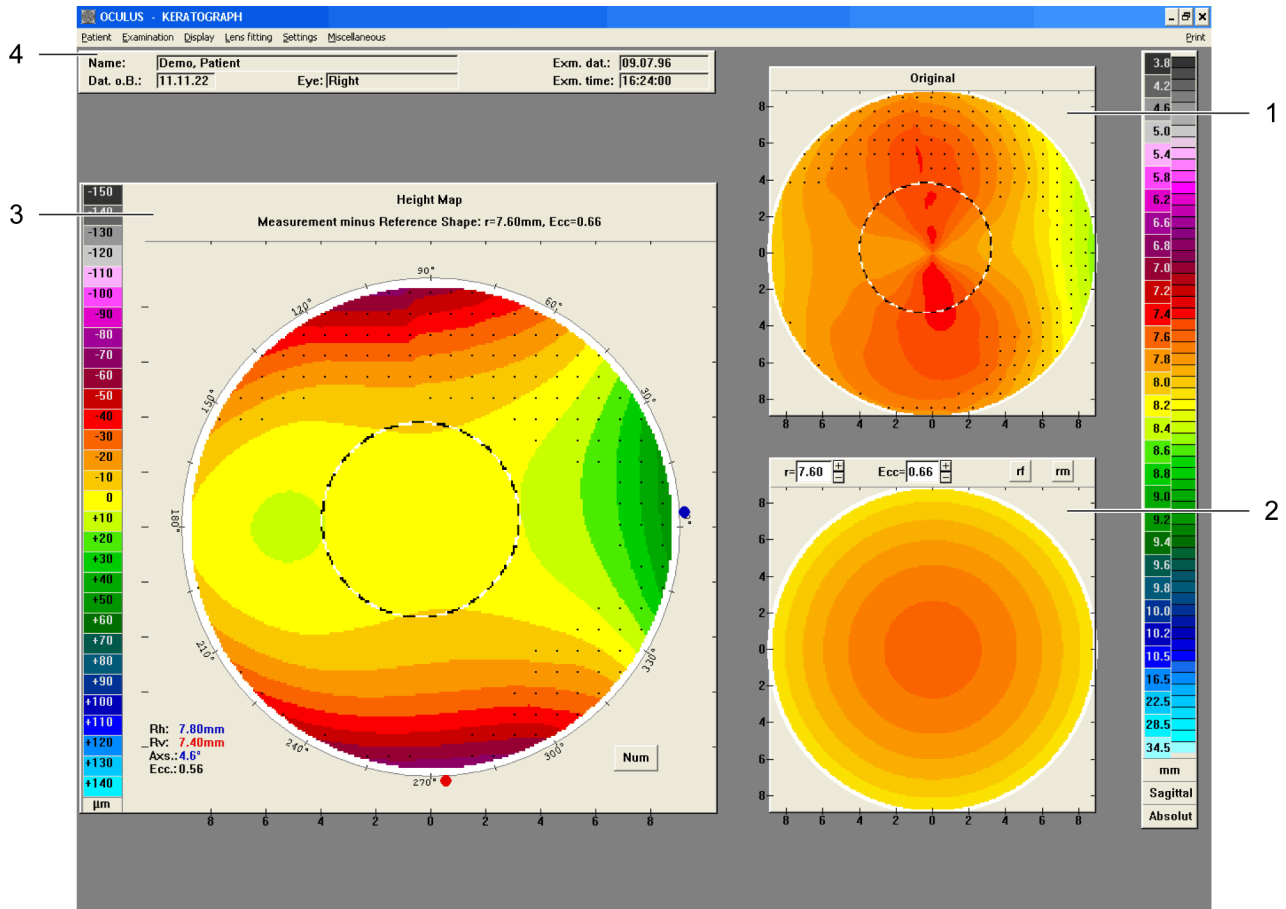


Fig. 3-34: Changing the spectacle power values

3.8 Height Map

During the mathematical analysis of the measurements, the keratograph generates a three-dimensional height model of the cornea, the so-called height data. This model is the basis for all additional calculations.

→ In the "Display" menu, select the menu item [Height Map].



1 Original topography map

3 Elevation

2 Reference shape

4 Patient and examination data

Fig. 3-35: Elevation display

Use of elevation offers the following advantages:

- Elevation provides an exact statement of the true surface figure of the cornea. The position of the keratoconus apex in the elevation display corresponds rather with reality than the position in the sagittal or tangential-radial display.
- Elevation provides ample information which can only be determined by additional calculations.
- Elevations can be defined independent of device type as an exchangeable standard.
- Fewer fixation artefacts results when elevation is applied. Pseudokeratoconi occur less frequently for this reason.
- Elevation data is the starting point for analyzing aberrations of the cornea surface.
- The height data reveal how much of the cornea would mathematically have to be removed in laser surgery procedures in order to achieve the desired reference surface from the original measurement.

Height data can be shown as absolute or relative values. Relative means that the difference in height of the measurement and the reference surface are output.

The absolute sagittal height P_A of a meridian section denotes the difference in height between a local point on the cornea and a plane that comes into contact with the cornea in the center.

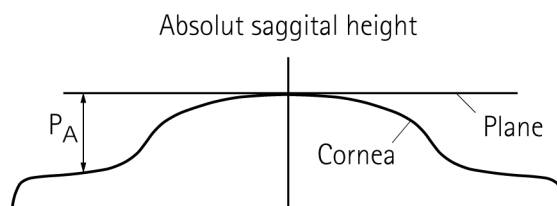
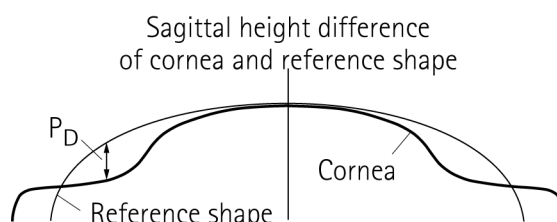


Fig. 3-36: Definition of the absolute sagittal height

The sagittal height difference P_D between the cornea and the reference shape can be a negative or a positive: In case of a negative sign, the reference shape ranges above the cornea; a positive sign indicates that the reference shape ranges below the cornea.



The following individual maps are displayed on the height data screen:

- Patient and examination data ([sect. 3.1.1, page 22](#))
 - Standard topography map ([sect. 3.1.2, page 23](#))
 - Topography map (2) of the reference shape ([sect. 3.8.1, page 62](#))
 - Height data (3) as sagittal height differences between the corneal measurement and the reference shape ([sect. 3.8.2, page 63](#))
- ➔ If you click in any of the three color maps, the corresponding value at that location is displayed in all three maps.

3.8.1 Reference shape

To present the height data in the form of height maps, an ellipse is used in the program as the reference shape. The advantage of this reference shape consists in the fact that is very close to the true shape of the cornea.

The topography of the reference shape is displayed at the bottom right.

- ➔ Activate the [rm] button to use the mean central radius of curvature of the cornea and its eccentricity increased by 0.1 for calculation of the reference shape. These parameters are ideal for displaying normal and astigmatic corneas and are often used in manual topography programs too.
 - ➔ Alternatively, press the [rf] button to use the flat central radius of curvature of the cornea and its eccentricity increased by 0.1 for calculation of the reference shape. This setting is beneficial for displaying keratoconus in particular, as the apex position is immediately visible.
 - ➔ Alternatively, adjust the radius of the reference shape in the field "r =" and the eccentricity in the field "Ecc =" directly.
 - ➔ Heed the following information about the two parameters:
 - **r =:** If you enter a value of "0" here, absolute height data will appear.
 - **Ecc =:** If you enter a value of "0" here, a sphere will be used as the reference shape.
- After changes are made in these fields, all maps are automatically updated immediately.

3.8.2 Elevation

The map at the left hand side of the screen is a graphic presentation of the height data in terms of sagittal height differences between the corneal measurements and the reference shape in the map at the left hand side of the screen. The following values are displayed at the bottom left of this map:

- **Rh:** Horizontal radius of curvature in the center, shown as a radius value in mm or as a refractive power in diopters.
- **Rv:** Vertical radius of curvature in the center, shown as a radius value in mm or as a refractive power in diopters.

Note

Switching from displaying the information as a radius of curvature or as a refractive power and vice-versa is done on the "Change settings" screen ([sect. 7.1.6, page 108](#)). In addition, you can also set there whether the horizontal and the vertical or the flat and the steep radius of curvature are to be displayed.



- **Axis:** Axial bearing of flat radius.
- **Ecc.:** Mean eccentricity of the cornea at 30°.
- ➔ Press the [Num] button to display or hide the height values in polar coordinate form in the height map. If you know the apex depth of spherioaspheric or quadrant lenses, you can thus assess their fit.

Color bars

Two color bars are shown in the height data map.

- The right color bar is the same as the color bar that is displayed in the topography map on the overview screen ([sect. 3.1.2, page 23](#)).
- The left color bar is assigned to the height data. Different colors are assigned to the various values of deviation. The resolution of the color bar, i.e. which deviations are represented with a color, can be adjusted.
- ➔ Click on the color bar with the left mouse button. The following selection dialog box appears:

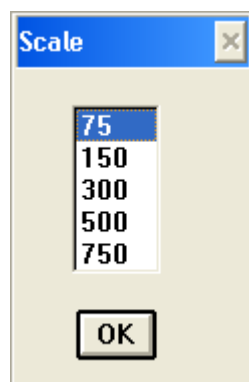


Fig. 3-37: Scale selection

- ➔ Select the desired resolution from the list of options.

3.8.3 Example of a Height Map Application

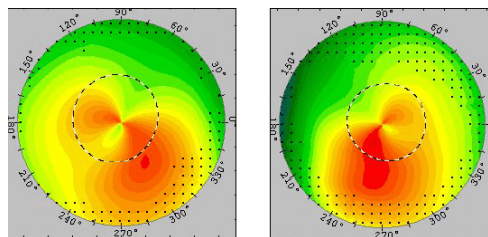
The conventional presentation of keratoconi using sagittal or tangential radii can be artificially falsified. The position of the apex is often shown at an inaccurate location. Clinical findings in conjunction with fluo images show that the height value map is more realistic. The conus apex is always located at the end of the loop-like bulge of the contour lines. Due to the tilt of the lens on the eye, the apex in the fluo image is located somewhat closer to the loop.



Note

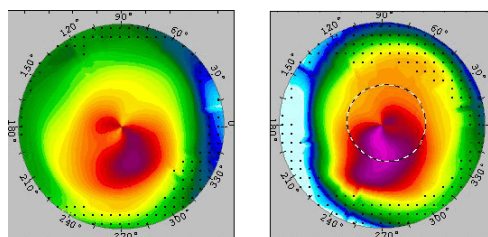
In the following example maps, the left image shows the map for the left eye and the right image that for the right eye.

Presentation by means of Sagittal Radii



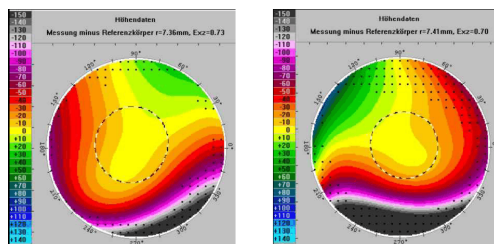
The hourglass shape in the center of the map is an artifact inherent to the display method. In the right eye, the apex appears to be located nasal and inferior, while in the left eye it appears to be located inferior.

Presentation by means of Tangential Radii



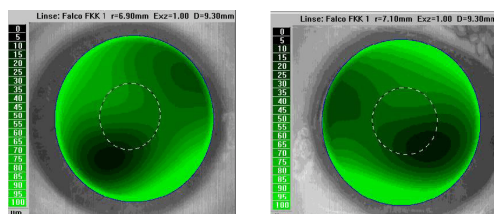
This method exhibits the same problems as those in the sagittal radii presentation, but often provides clearer results.

Elevation display



The apex position on both sides is located at the temporal, inferior pupillary margin. Both are in very good agreement with the clinical findings (ophthalmoscopy in regressive light) and the fluo image.

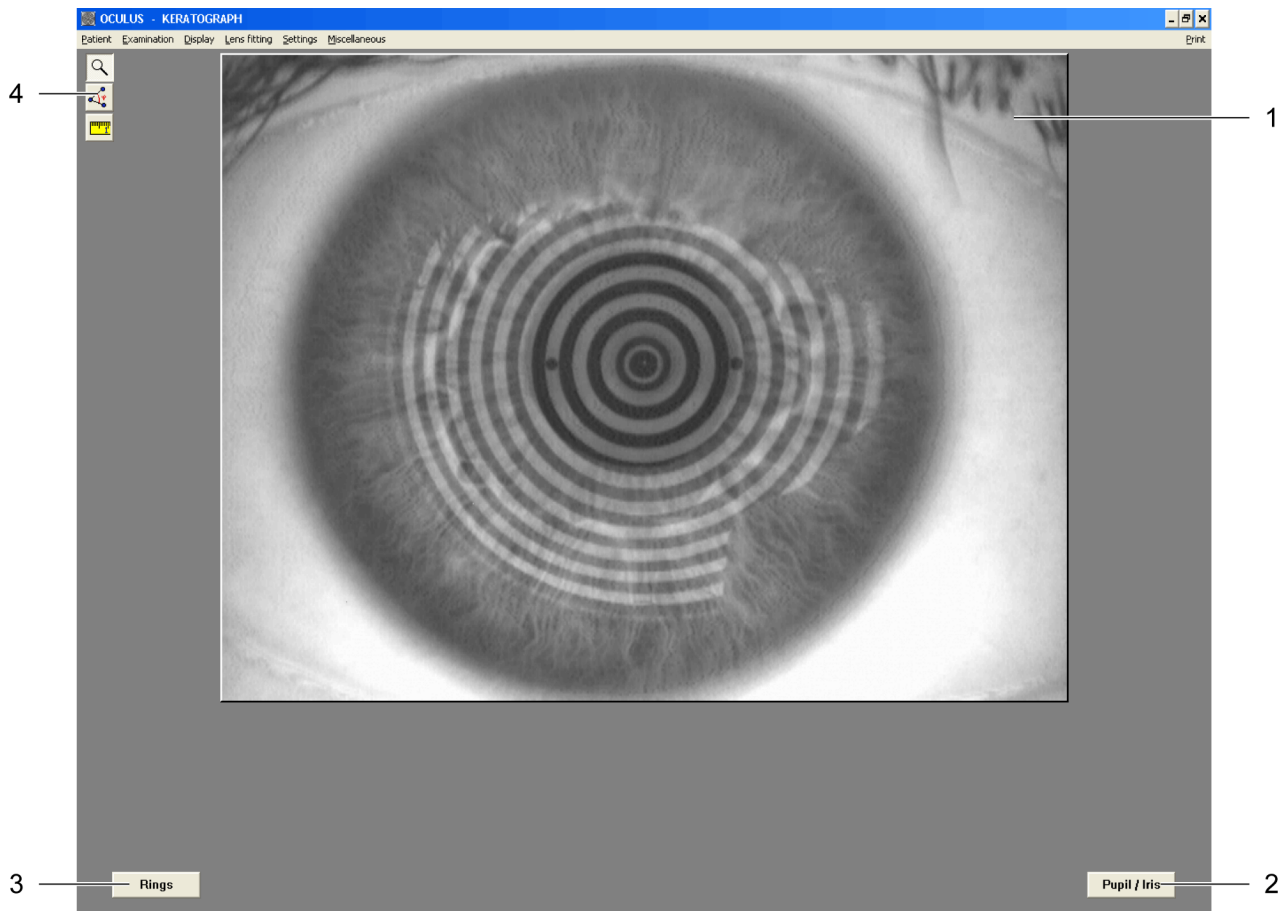
Simulated Fluo Image



Right: Shows lens contact in the apex area temporal and inferior to the pupillary margin, as well as nasal and superior. Left: Shows apex contact in the temporal/temporal-inferior area of the pupillary margin and nasal at the 9-10 o'clock position.

3.9 Camera image

→ In the "Display" menu, select the menu item [Camera Image].



1 Camera image

2 [Pupil/Iris] button

3 [Rings] button

4 Buttons for conducting the analysis

Fig. 3-38: Presentation of the camera image

The camera image of the measured eye is shown in original size in this presentation.

- ➔ Press the [Rings] button to display the ring edges determined by the image processing software in the camera image. This allows the image processing to be checked for accuracy and allows you to assess the reflection of the Placido system yourself. Press the button again to switch off the ring edges again.
- ➔ Press the [Pupil/Iris] button to mark both the edge of the iris and the pupil. You can thus check the measurement of the corneal diameter. Press the button again to switch off the markings.

3.9.1 Zooming In the Presentation

- ➔ Activate the  button at the top left of the camera image.
- ➔ Move the mouse to the desired place in the camera image and click the left mouse button.
- ➔ A zoomed-in view of the section of the camera image around the position at which the mouse is located is displayed in a separate window for as long as you hold down the mouse button.
- ➔ Press the right mouse button to cancel the zoomed-in view again.

3.9.2 Determination of an Angle

You can determine the angle between any two lines in the camera image.

- Activate the  button at the top left of the camera image.
- Move the mouse to the starting point of the first line and press the left mouse button. This point is also the starting point of the second line.
- Move the mouse to the end point of the first line and press the left mouse button again.
- Move the mouse away from the end point of the first line to the end point of the second line. The display of the angle between the two lines is continuously updated as you move the mouse.
- Press the left mouse button again to set the end point of the 2nd line and to permanently display the angle.

Note

- Activate the menu item [Camera Image] again in the "Display" menu to delete the display of all angles and distances.



3.9.3 Determination of a Distance

- Press the  button at the top left of the camera image.

Note

The distance between two points can then be determined in the camera image in the same way as in the zoomed out view ([sect. 3.1.5, page 25](#)).



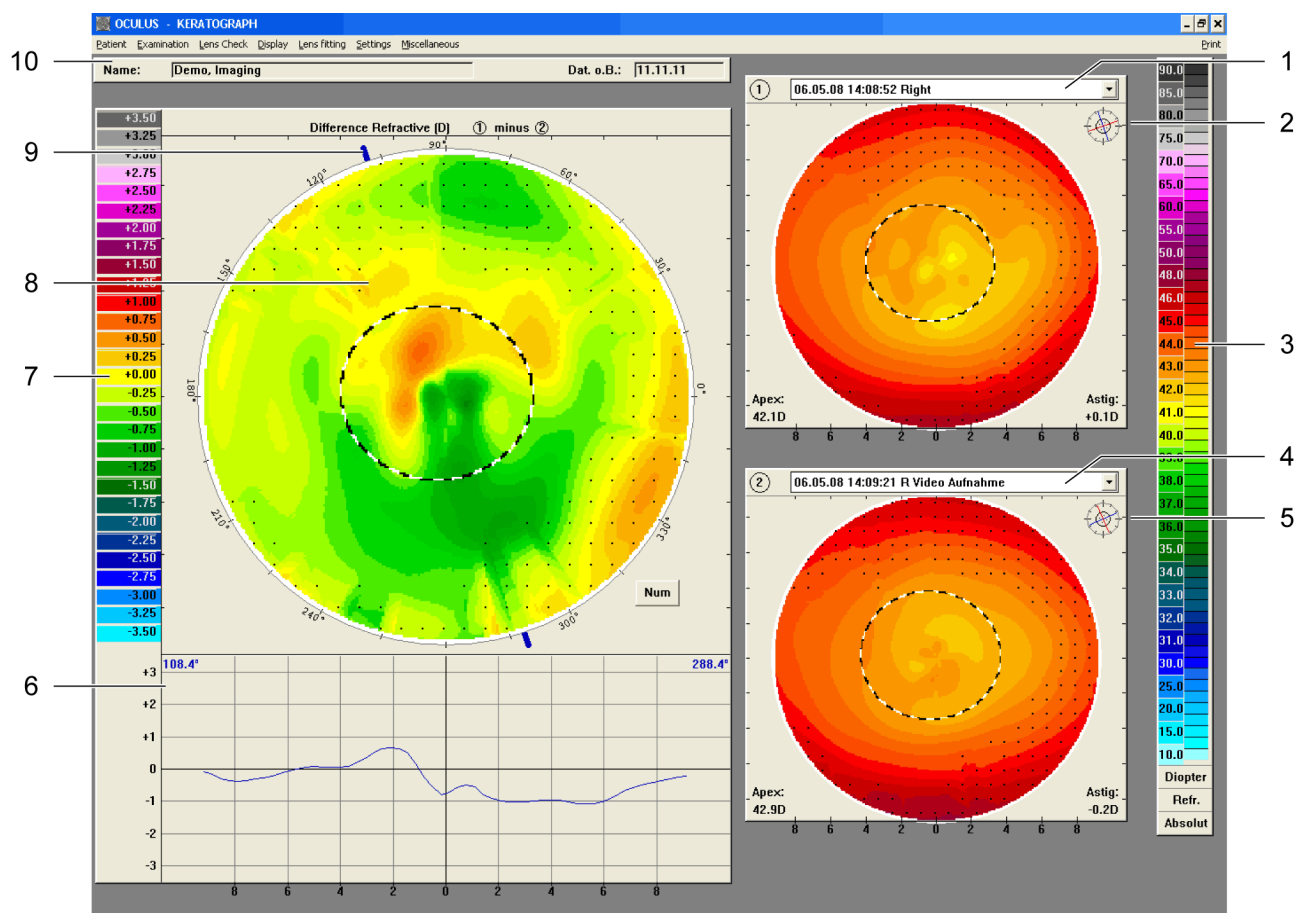
Note

- Activate the menu item [Camera Image] again in the "Display" menu to delete the display of all angles and distances.



3.10 Refractive Compare

➔ In the "Display" menu, select the menu item [Refractive Compare].



- | | |
|--|---|
| 1 Drop-Down-List Examination 1 | 6 Difference graph for the meridian plane |
| 2 Position of the main meridians for examination 1 | 7 Color bar for the difference map |
| 3 Color bar for the topography maps | 8 Difference display |
| 4 Drop-Down-List Examination 1 | 9 Location of the meridian plane |
| 5 Position of the main meridians for examination 1 | 10 Patient data |

Fig. 3-39: "Refractive Compare" display

The maps on this comparison screen are ideal for showing changes in the corneal refractive power, resulting e.g. from wearing Ortho-K lenses (or after refractive surgery). The following information is displayed for this purpose:

- Patient data ([sect. 3.1.1, page 22](#))
- Two refractive topography maps of the selected examinations ([sect. 3.7.1, page 58](#))
- Map showing the differences between the two topography maps ([sect. 3.10.1, page 69](#))

The following numeric values are shown in the topography maps of the examinations at the bottom left and right:

- **Apex:** Power at the apex in diopters
- **Astig:** Astigmatism in diopters

In addition, the position of the main meridians is shown graphically at the top right of the respective map.

3.10.1 Difference display

- Select the examination that is to be used as the basis (minuend) from the drop-down list in the top right topography map (1).
- Select the examination, the results of which are to be subtracted (subtrahend), from the drop-down list in the bottom right topography map (4).

Example: If you select Examination A in the top topography map and Examination B in the bottom topography map, the difference Examination A - Examination B is shown in "Difference Refractive" map.

- Press the [Num] button to display or hide the numeric values for the differences in refraction power in the various zones of the cornea. The numeric values are determined from the values measured within each zone and are displayed in the center of that zone.

Note

The displayed numeric value is a mean value for the whole zone and does not relate to an individual measuring point!



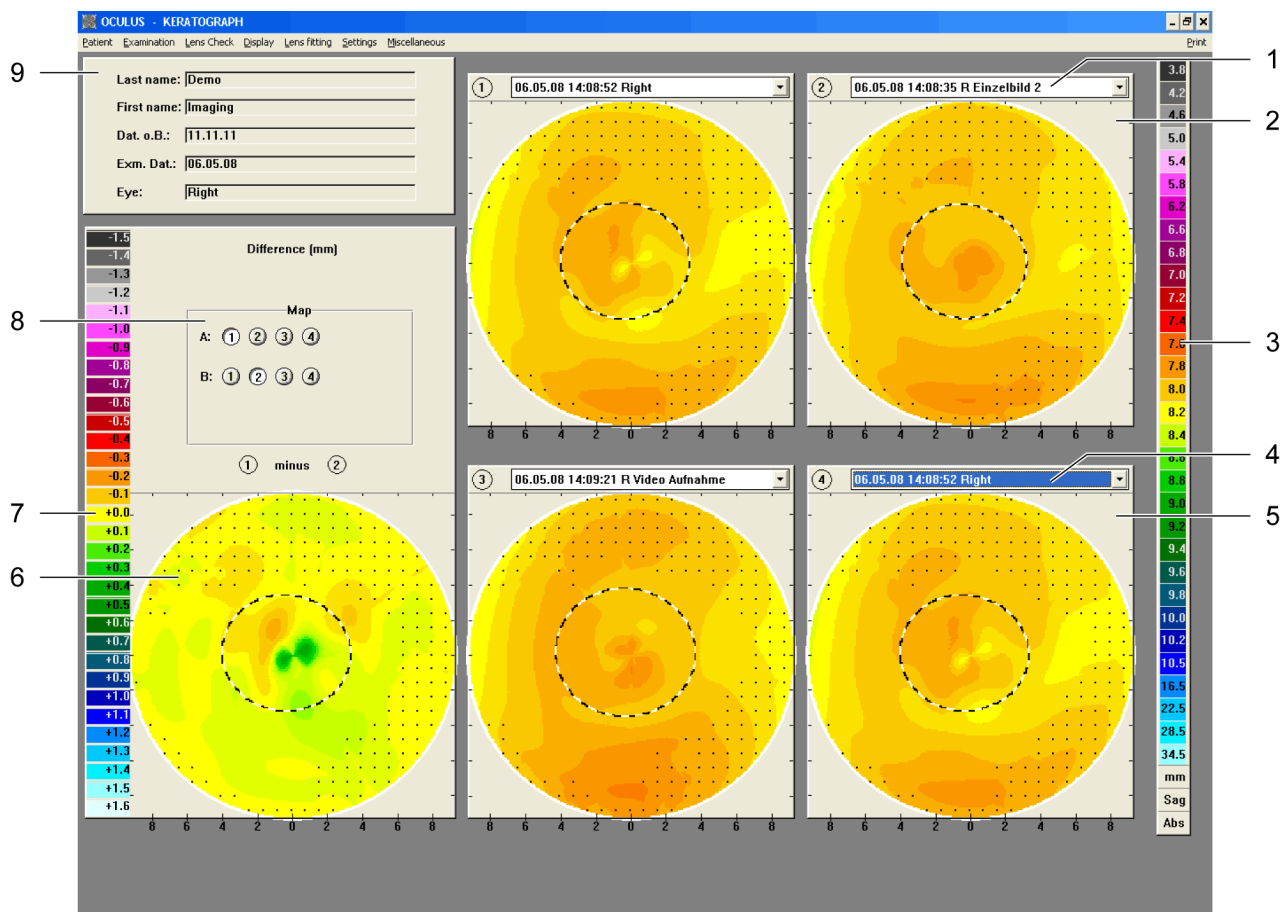
3.10.2 Adjusting the Meridian Plane

A section of the difference map (8) is output in the graph (6) below the difference map. The distance in mm around the apex of the cornea is plotted on the abscissa (X axis) of this graph and the power in diopters at the respective point is plotted on the ordinate (Y axis).

- In the difference map, activate the blue line (9), which marks the position of the meridian, with the mouse and press and hold down the left mouse button.
- To move the meridian plane, move the mouse clockwise or counter-clockwise accordingly. The position of the meridian plane is shown in the graph at the top left and right.

3.11 Compare examinations

- ➔ In the "Display" menu, select the menu item [Compare Examinations]. The following tab appears.



- | | |
|------------------------------------|------------------------------------|
| 1 Drop-Down-List Examination 2 | 6 Difference display |
| 2 Topography map 2 | 7 Color bar for the difference map |
| 3 Color bar for the topography map | 8 Examination selection |
| 4 Drop-Down-List Examination 4 | 9 Patient and examination data |
| 5 Topography map 4 | |

Fig. 3-40: Display "Compare examinations"

In addition to the patient and examination data ([sect. 3.1.1, page 22](#)), the topography maps of up to four examinations can be displayed here. Selection of the individual examinations occurs analogously to that of display "Refractive Compare" ([sect. 3.10.1, page 69](#)).

In the "Difference" box (8) at the left hand side of the screen, you can also select the examinations for which the difference map is to be calculated.

- ➔ Select the examination with the upper options button which should be used as the basis (Minuend).
- ➔ Select the examination with the lower options button from which the results should be taken (Subtrahend).

Example:

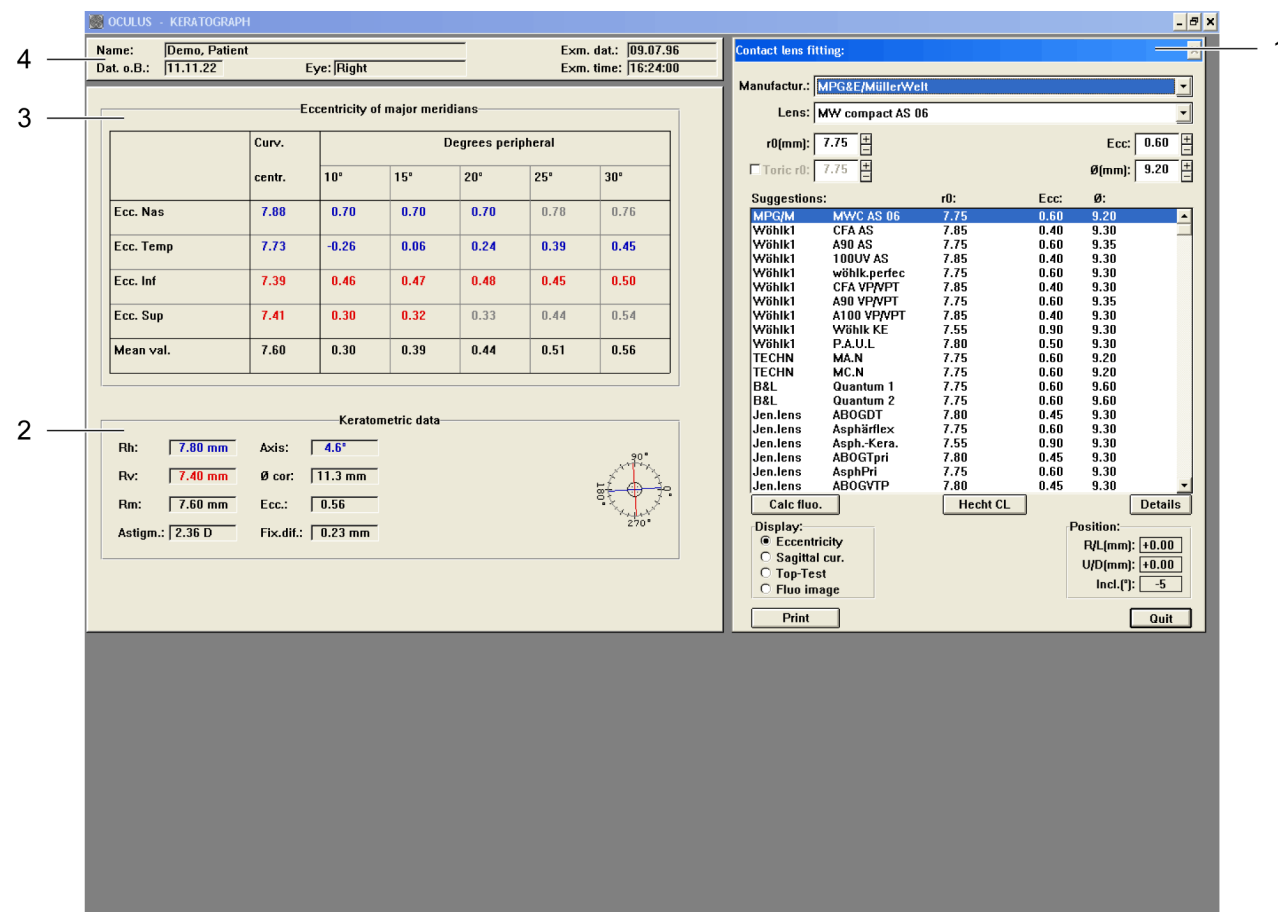
If you activate Examination 1 with the top option buttons and Examination 2 with the bottom option buttons, the comparison map will be calculated in the same way as for the "Refractive Compare" map. You can also calculate the inverse here, i.e. the difference of exam 2 to exam 1. Select examination 2 with the upper options button and then examination 1 with the lower options button to do this.

The corresponding results will be output in the difference display again in the lower left (6).

4 Contact lens fitting

Measurement of the corneal thickness geometry enables thorough user support for fitting contact lenses. Inserting a contact lens and checking the fit of the lens can be simulated on the computer without having to bother patient.

→ Select the menu item [Lens fitting].



1 Contact lens fitting

2 Keratometric data

3 Eccentricity chart

4 Patient and examination data

Fig. 4-1: Display "Contact lens fitting"

4.1 Cornea data

In the left part of the screen, the following is displayed:

- Patient and examination data (sect. 3.1.1, page 22)
- Eccentricities of the major meridians or sagittal radii (sect. 4.2.3, page 79)
- Keratometric data (sect. 3.1.4, page 24)

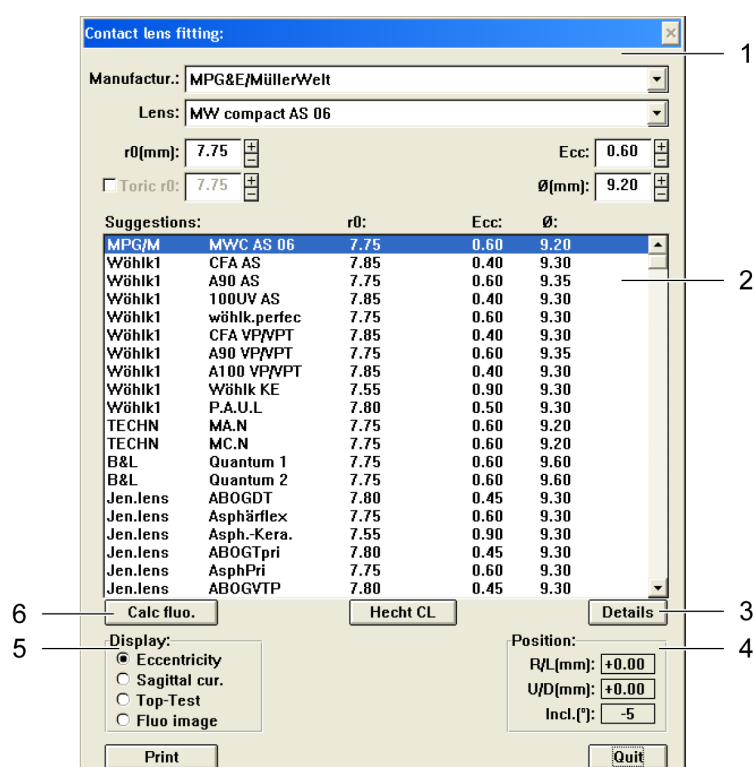
This data helps provide the contact lens fitter with a good impression of the shape of the cornea from the center to the periphery.

4.2 Contact lens data

The actual selection of the lens to be fitted is made in the right side of the screen (1).

4.2.1 Selecting the Contact Lenses

The Keratograph software includes a list of different models and types of contact lenses ([sect. 7.3, page 115](#)). The program creates a list of suggestions from this complete list based on the corneal geometry data measured.



1 Selected lens in the suggestion list

2 Suggestion list

3 [Details] button

4 Display "Position"

5 Selection "Display"

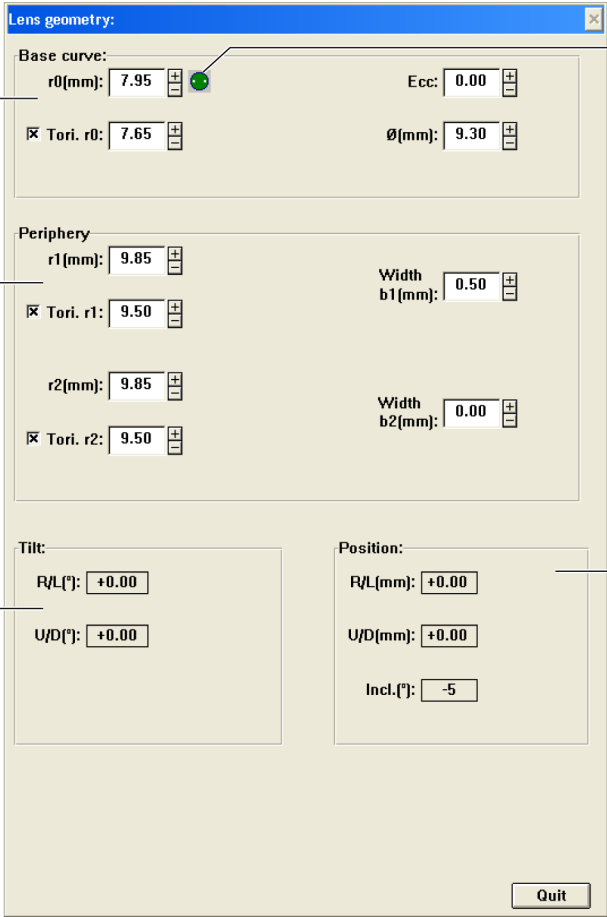
6 [Calc. fluo.] button

Fig. 4-2: Detail "Contact lens fitting"

The suggestion list (2) is sorted according to the following criteria:

- Lens geometries which are best suited to the measured cornea mathematically are at the start of the list. The list of precedence that you generated is also taken into account accordingly ([sect. 7.3, page 115](#)).
- Soft lenses are placed at the end of the list independent of fitting quality.
- ➔ Select the desired lens type in the suggestion list (2).
- ➔ Alternatively, change the parameters for the currently selected lens directly in the data fields found in the "Contact lens fitting" group box (1).

- You can also change them using the buttons to the right of the individual fields. The buttons increase/decrease the value each time they are pressed to the next possible value. For example, the diameter increases from "9.20" to "9.60".
If the selected lens with the changed data is not available, a lens that comes as close as possible is selected.
- To define contact lenses yourself, enter the value "Mathematic" (first field) in the field "Manufacturer".
All individual parameters may now be defined independent from the actual availability of the lens in the list.
- You can change the way in which the cornea data are displayed with the options in the "Display" (5) box.
- Press the [Details] button to edit additional contact lens parameters. The following dialog appears:



The screenshot shows the 'Lens geometry' dialog box with the following fields and callouts:

- 1** points to the 'Flat meridian alignment' section, which includes 'Base curve' (r0(mm): 7.95, Ecc: 0.00), 'Tori. r0' (7.65), and 'Ø(mm)' (9.30).
- 2** points to the 'Position' section, which includes 'R/L(mm)' (+0.00), 'U/D(mm)' (+0.00), and 'Incl.(°)' (-5).
- 3** points to the 'Tilt' section, which includes 'R/L(°)' (+0.00) and 'U/D(°)' (+0.00).
- 4** points to the 'Periphery' section, which includes 'r1(mm)' (9.85), 'Tori. r1' (9.50), 'r2(mm)' (9.85), 'Tori. r2' (9.50), 'Width b1(mm)' (0.50), and 'Width b2(mm)' (0.00).
- 5** points to the 'Base curve' field (r0(mm): 7.95).

A 'Quit' button is located at the bottom right of the dialog.

1 Flat meridian alignment

2 Position

3 Tilt

4 Periphery

5 Base curve

Fig. 4-3: Lens geometry

- Enter the desired parameters for the base curve (5) and the periphery (4) into the respective entry fields.

**Note**

Changing the parameters in the group box "Periphery" is only sensible if you have selected the entry "Mathematic" in the field "Manufacturer" beforehand. Additional notes on periphery parameters can be found in the contact lens settings description ([sect. 7.3.3, page 117](#)).

The calculated tilt of the lens can be viewed in the group box "Tilt" (3); the movement and rotation (Inclination) can be viewed in the group box "Position" (2). The alignment of the flat meridian (1) is also displayed.

- ➔ Confirm your entries with the [OK] button.
- ➔ Press the [Calc. fluo.] button to simulate a fluorescent image ([sect. 4.2.2, page 77](#)). However, this is only possible for rigid contact lenses; for soft contact lenses (the option "Soft" is active in the "Ecc." field), this button is disabled.

The individual fields in the group box "Position" (4) display the offset and rotation of the contact lens on the cornea.

- **Field "R/L":** A positive value describes movement to the right, and a negative value a movement to the left.
- **Field "U/D":** A positive value describes an upward movement, and a negative value a downward movement.
- **Field "Incl.":** Contact lens rotation. This is the angle between the horizontal and connecting line of both selections. A positive value describes a clockwise rotation, and a negative value describes counter-clockwise rotation.

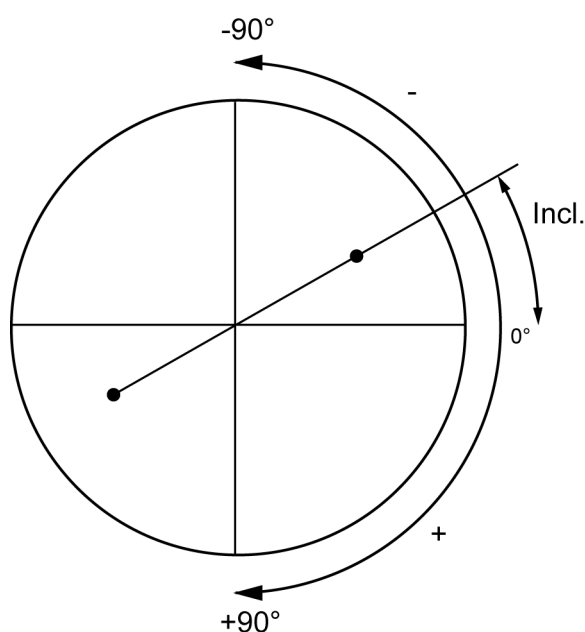


Fig. 4-4: Inclination angle definition

The individual fields in the group box "Tilt" (3) display the tipping of the contact lens on the cornea.

- **Field "R/L":** A positive value describes tipping to the right, and a negative value a tipping to the left.

- Field "U/D": A positive value describes an upward tipping, and a negative value a downward tipping.

4.2.2 Fluorescent image simulation

This display visually outputs the distance values between the cornea and contact lens.

→ Press the [Calc. fluo.] button on the "Contact lens fitting" screen.

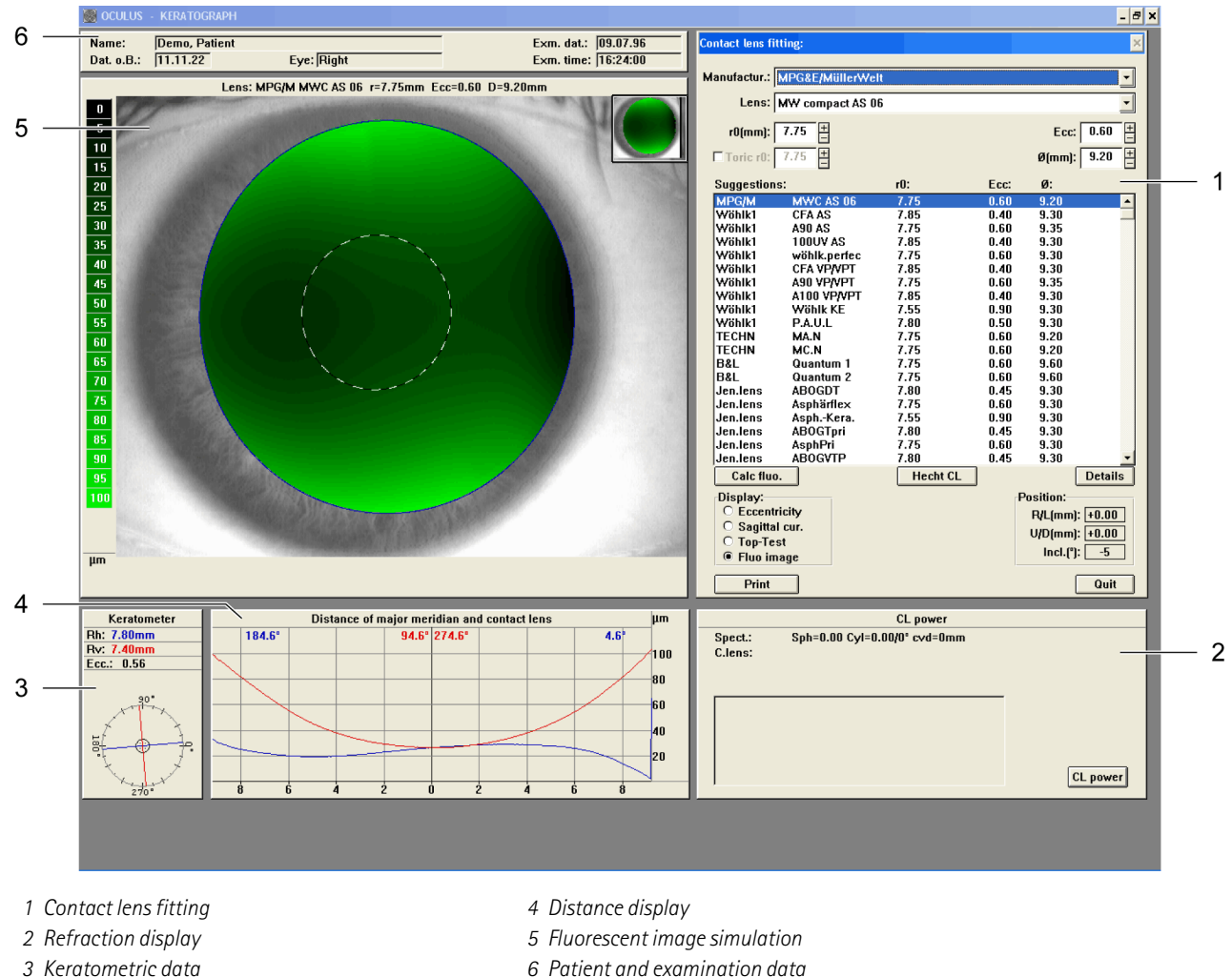


Fig. 4-5: Display "Fluo image"

Below center (4) is a display of both main sections of the contact lens. For a flat fitting, the curve is bent upwards, for steep fittings the curve is bent downwards, and for a parallel fitting the curve runs horizontally.

After the first fluo-image simulation, the field "CL power" (2) is activated at the bottom right of the screen. The refractive powers of the contact lens can be calculated here based on the patient's spectacle lens power and the lens type (sect. 4.2.5, page 83 through sect. 4.2.7, page 87).

The main part of the screen (5) shows a calculation of the corneal distance values for the entire contact lens. The results are displayed in different "fluorescent" shades of green. The data for the contact lens used is output in the center above the display.

Movement and rotation of the contact lens

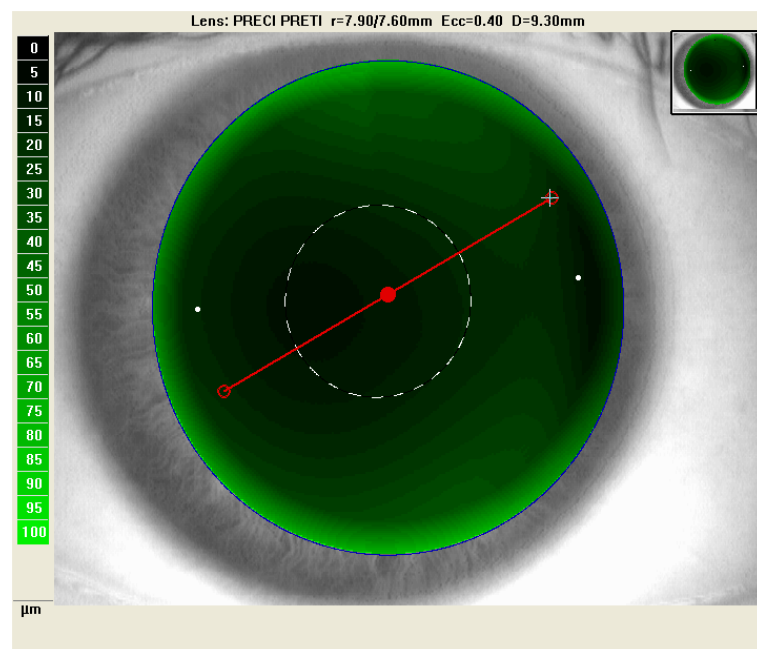
- Click with the left mouse button in the fluorescent image at any location and hold down the mouse button. The edge of the contact lens is shown in red.



- Move the contact lens within the permitted area. A dialog confirmation box appears in which you are asked whether the lens is to be moved.

Toric contact lenses can also be rotated at the center.

- Click the fluorescent image close to the white markings and hold down the mouse button. The connection of both selection points is shown in red.



- Rotate the contact lens. A query appears asking whether the contact lens should be turned.

Even after moving and rotating, the fluorescent image will be calculated and displayed with the new position of the contact lens. The current position of the lens is displayed in the group box "Position".

The previously created fluorescent image simulations can also be accessed via the above right fluo icons (max. 7 images) in order to quickly switch between different fittings. If more than seven fluorescent images are created, then the uppermost icon will be removed and the one at the bottom will be moved upwards.

- Select the desired simulation via the fluo icons.
- To delete a fluo icon, click on it with the right mouse button. A query will appear to ask if you would really like to delete the image.
- Press the [Delete] button. The icons below are moved upwards again.

Changing the scale of the fluorescent image

The display for the fluorescent image simulation can be adjusted similarly to that of the color bars of the maps.

- Click with the left mouse button on the color bar to adjust the indicated setting. The following dialog appears:

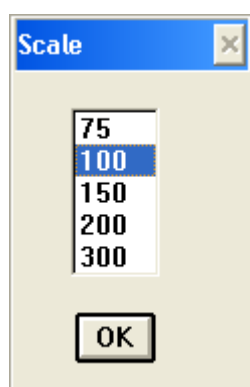


Fig. 4-6: Detail "Contact lens fitting"

- Select the maximum color scale value.
The green shades are distributed from "0" (dark green) to the value set here (light green). As a default, the value "100 μ m" is selected. The selection of another maximum value is helpful, for example, in the case of a keratoconus, since the distance range at the edge area of poorly fitting contact lenses (distances > 100 μ m) is easy to recognize. In case you select another maximum value as the standard value, the note "!!Scale!!" appears next to the color scale.
- To finish, press the [Save] button. A new fluo image will be created with the changed settings.

4.2.3 Selection of the Mode of Display

In the top right part of the display, various values can be displayed in table form, or the fluo-image can be displayed. You can select the display mode with the options in the "Display" box.

The following colors are thereby assigned to the values in the various tables:

- **Red:** steep meridian

- **Blue:** flat meridian
- **Grey:** Interpolated values

1) Eccentricity

In the table of eccentricities of the major meridians, the eccentricity progression is listed from the inside to the outside. A mean value of the eccentricity is calculated and displayed for each peripheral angle. The individual central radii of curvature are listed in the left column.



Note

The values at 30° are used to calculate the mean eccentricity,

2) Progression of the Sagittal Radii

In the table of sagittal radii of the major meridians, the progression of the sagittal radii is listed numerically from the inside to the outside. A mean value of the sagittal radii is calculated and displayed for each peripheral angle. The individual central radii of curvature are listed in the left column.

4.2.4 Use Hecht Basic Module

General Information about the Hecht Software

A special fitting program from the company Hecht is available for fitting Hecht contact lenses. This uses the fitting rules of the company Hecht to generate a suggestion of which contact lenses to use based on the measured corneal geometries. Here too, the appropriate fluo-image can be simulated, allowing simple and difficult fits to be conducted in a structured manner.

In addition to the Hecht basic module, the company Hecht also offers extended software modules. With the help of these modules, the individual contact lens zones can be defined in more detail:

- Seefree module
- Expert version
- Expert+Seefree module
- Expert+Quadro module
- Expert+Seefree+Quadro module

Furthermore, all of the above-mentioned versions of the Hecht fitting program can be upgraded with the APEX(r) software. This module allows:

- The optimal contact lens power to be calculated,
- A personalized fitting contact lens (rotationally symmetric, toric, keratoconic etc.) to be calculated, and
- Calculation of the final contact lens.

You can also conduct two additional measuring functions with the help of the APEX(r) software:

- Lid angle measurement ([sect. 3.6, page 49](#))
- Near vision height measurement ([sect. 3.5, page 39](#))

Contact information:

Hecht Contactlinsen GmbH

Dorfstraße 2-4

D - 79280 Au bei Freiburg

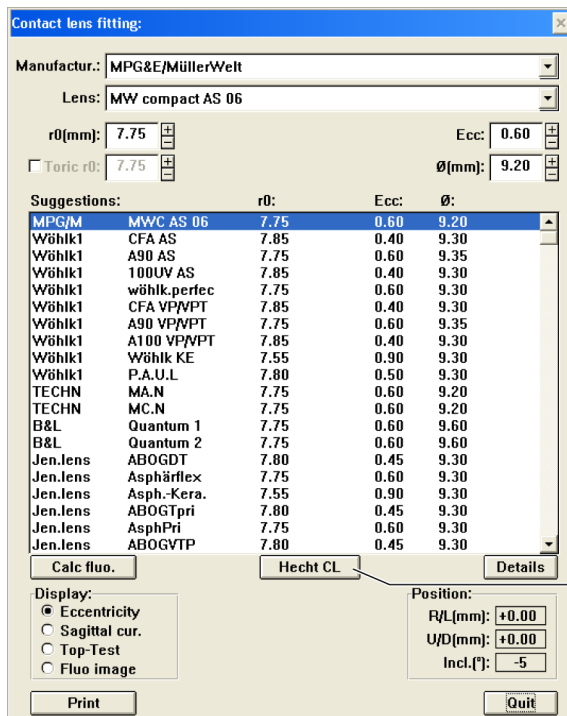
Tel.: 0761 - 40105-0

Fax: 0761 - 40105-22

info@hecht-contactlinsen.de

Working with the Hecht Basic Module

- ➔ Press the button [Hecht CL] ([Fig. 4-7, page 81](#)) on the "Contact lens fitting" screen.



Suggestions:	r0:	Ecc:	Ø:
MPG/M	MWC AS 06	7.75	0.60 9.20
Wöhlk1	CFA AS	7.85	0.40 9.30
Wöhlk1	A90 AS	7.75	0.60 9.35
Wöhlk1	100UV AS	7.85	0.40 9.30
Wöhlk1	wöhlk.perfec	7.75	0.60 9.30
Wöhlk1	CFA VP/VPT	7.85	0.40 9.30
Wöhlk1	A90 VP/VPT	7.75	0.60 9.35
Wöhlk1	A100 VP/VPT	7.85	0.40 9.30
Wöhlk1	Wöhlk KE	7.55	0.90 9.30
Wöhlk1	P.A.U.L	7.80	0.50 9.30
TECHN	MA.N	7.75	0.60 9.20
TECHN	MC.N	7.75	0.60 9.20
B&L	Quantum 1	7.75	0.60 9.60
B&L	Quantum 2	7.75	0.60 9.60
Jen.lens	ABOGDT	7.80	0.45 9.30
Jen.lens	Asphärflex	7.75	0.60 9.30
Jen.lens	Asph.-Kera.	7.55	0.90 9.30
Jen.lens	ABOGTpri	7.80	0.45 9.30
Jen.lens	AsphPri	7.75	0.60 9.30
Jen.lens	ABOGVTP	7.80	0.45 9.30

Fig. 4-7: Calling up the Hecht basic module

- ➔ First select the desired lens type (rigid or soft contact lens) by pressing the appropriate button.

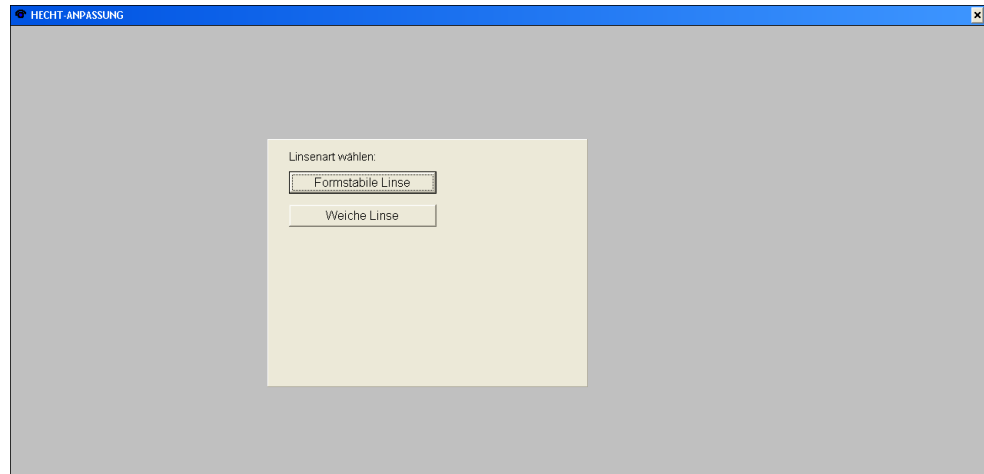


Fig. 4-8: Selection of the lens type

If the APEX(r) software is **not** installed, the following screen appears:

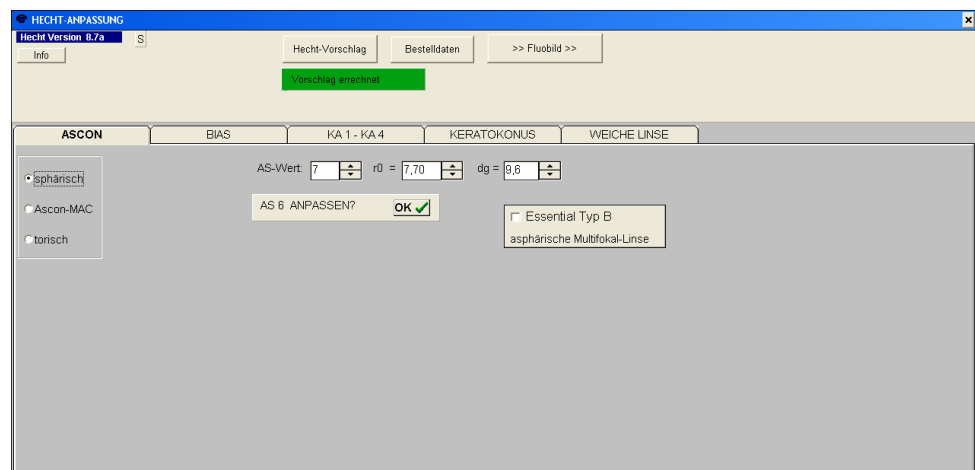


Fig. 4-9: Hecht basic module without installed APEX(r) software

If the APEX(r) software is installed, the following screen appears:

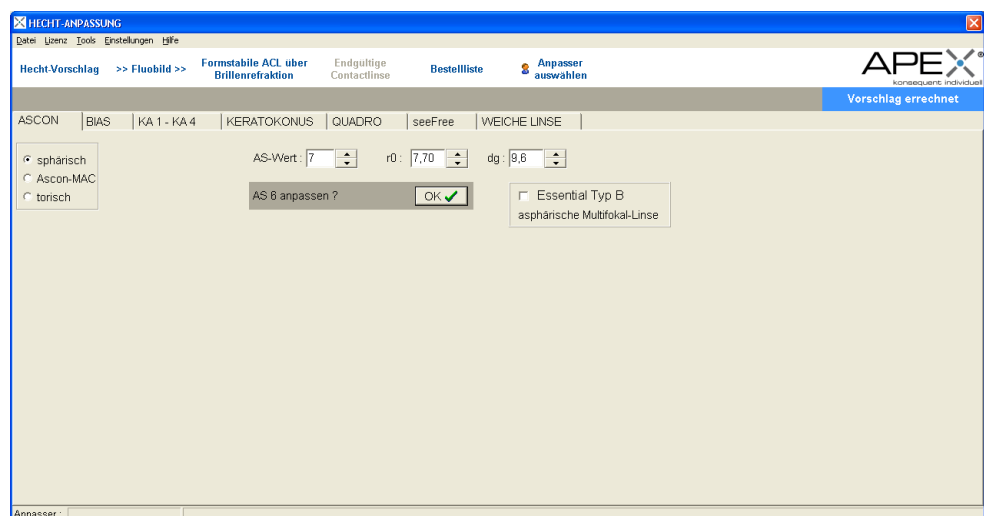


Fig. 4-10: Hecht basic module with installed APEX(r) software

- ➔ Select the desired lens.
- ➔ Finally, press the button [Fluo image] in the Hecht software. The Hecht software is closed and the fluo image for the selected contact lens is displayed.

Note

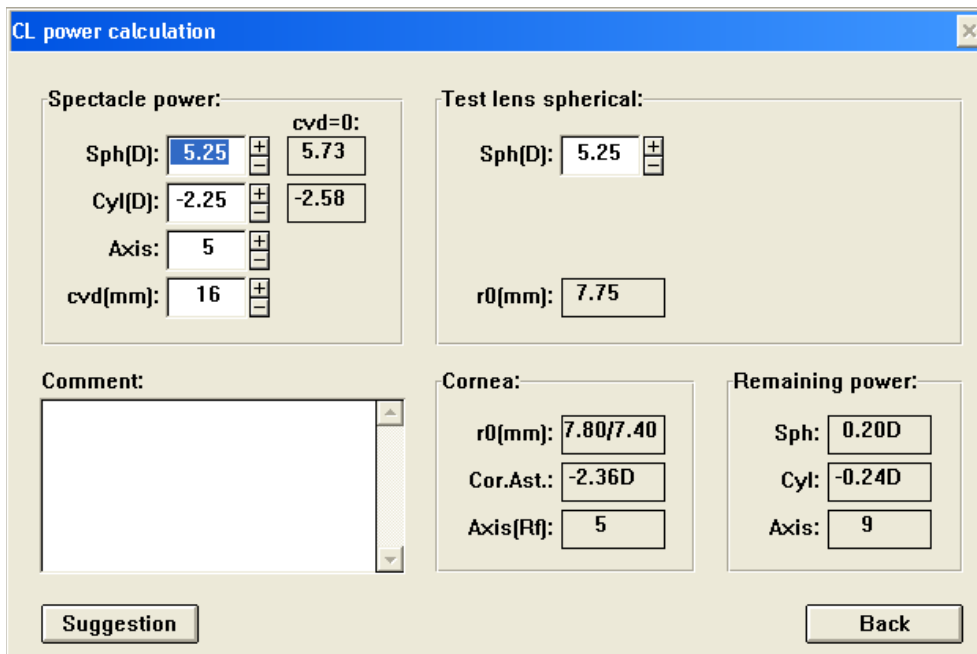
To change the geometry data of a Hecht lens, you must always first press the [Hecht CL] button. For that reason, the respective input fields in the keratograph software are disabled after a contact lens has been selected in the Hecht software. This ensures that a contact lens selected in the Hecht software can only be modified using the Hecht software. As soon as another contact lens suggestion or the manufacturer is selected, the input fields are enabled again.



4.2.5 Power Calculation of Rotationally Symmetric Lenses

The CL Power module is used to calculate the necessary refractive power of the contact lens based on the spectacle lens power and the lens type.

- Conclude the selection of the contact lens back surface (i.e. the fluo image simulation) before you start the power calculation module. For rigid contact lenses, a change in the curvature of the back surface also requires other corrective powers of the contact lens.
- Press the [CL power] (2) button in the "CL power" display (Fig. 4-5, page 77). The following screen appears:



CL power calculation

Spectacle power: Sph(D): 5.25 Cyl(D): -2.25 Axis: 5 cvd(mm): 16		Test lens spherical: Sph(D): 5.25 r0(mm): 7.75	
Comment: [Text Area]		Cornea: r0(mm): 7.80/7.40 Cor.Ast.: -2.36D Axis(Rf): 5	
		Remaining power: Sph: 0.20D Cyl: -0.24D Axis: 9	
[Suggestion]		[Back]	

Fig. 4-11: Power calculation module for rotationally symmetric lenses

- First enter the patient's values in the "Spectacle Power" field.

Note

- Bear in mind that the cylinder must always be entered as a negative value.



- If spectacle power values have already been entered previously, these are taken over and do not have to be entered again ([sect. 3.7.3, page 60](#)).

The spectacle power is converted into the optical refraction using the corneal vertex distance (cvd) and is displayed in the "cvd=0" column.

- ➔ Press the [Suggestion] button. A contact lens suggestion is generated taking into account the power values, the curvature of the cornea and the selected contact lens back surface. The suggestion is carried over into the "Test lens spherical" box.
- ➔ Change the suggested contact lens, if necessary. Every time the value "Sph. (D)" is changed, the expected remaining power is automatically calculated and is displayed in the "Remaining power" box at the bottom right of the screen. This value corresponds to the over-refraction that would be needed if this contact lens were put onto the eye. The test lens selection should therefore minimize the expected remaining power.



Note

The expected remaining power is not a measured value but a **calculated** one that takes as many eye and contact lens parameters as possible (but not all) into account. This value should therefore be compared with the measured over-refraction after selecting the contact lens.

- ➔ Press the [Back] button to close the power calculation module and to transfer the new values into the power field of the contact lens fitting screen.

The other parameters on this screen are explained below.

"Test lens spherical" group box

- **r0 (mm):** The back surface curvature of the contact lens was previously determined with the fluo-image and is therefore only displayed here. This value can only be changed in the contact lens fitting screen (Fluo image simulation).

"Comments" group box

- ➔ You can enter any text into this field, which is then saved together with the power values and is thus also available later.

"Cornea" group box

The keratometric data for the cornea that have been determined by the keratograph are displayed here:

- **r0 (mm):** Central radii
- **Cor.Ast.:** Corneal astigmatism (central)
- **Axis (Rf):** Axis of the flat meridian

"Remaining power" group box

The values for the expected remaining power are shown here.

4.2.6 Calculating the Power of Toric Lenses

The power calculation for toric lenses is basically the same as that for rotationally symmetric lenses ([sect. 4.2.5, page 83](#)).

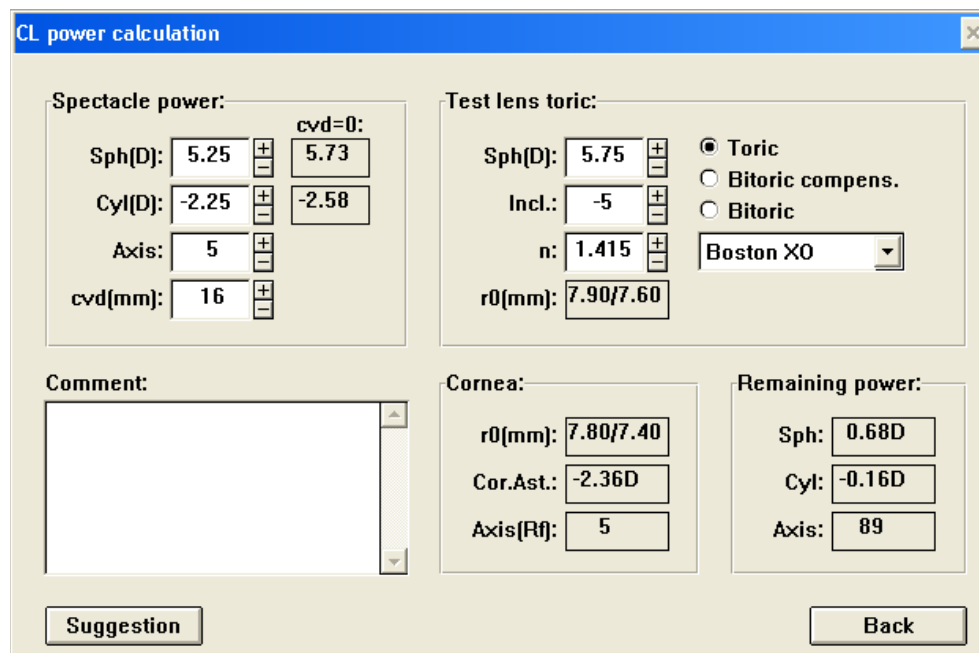


Fig. 4-12: Power calculation module for toric lenses

However, additional contact lens parameters can be set in the "Test lens toric" box.

- **Incl.:** The inclination (rotation) of the contact lens can be changed here. First select the inclination so that the flat meridian of the back of the contact lens matches that of the cornea.
- Correct the rotation in the field "Incl." if this value does not correspond with the actual position.
- Exit the power calculation module by pressing the [Back] button. After the inclination has been changed, the fluo image is automatically recalculated.
- **n:** On back toric lenses, the refractive index n of the contact lens material determines the degree of the induced astigmatism, and thus also the toric effect of the contact lens.
- Enter the refractive index of the contact lens material in this field.

Note

When using back toric contact lenses, the refractive index n must always be entered manually. It is not saved with the other contact lens parameters in the contact lens database.



- Alternatively, select the name of the material in the field at the right of the refractive index. The appropriate refractive index is then updated accordingly.



Note

The various materials and their corresponding refractive indices are saved in the file "C:\TOPO\N-MAT.TXT" in the form Refractive index = Material name. You can add to this file at any time using a text editor.

Selection of the Toric Lens Type

You can compare different lens types (e.g. back toric or bitoric) with respect to their corrective power.

- ➔ Choose one of the following three lens types.
- **Toric:** The back of this contact lens is toric (for better stability on the eye), the front, however, is spherical. Due to the difference in the refractive index of the contact lens material and the tear fluid, the toric back side of the lens causes an artificial, so-called induced astigmatism. Depending on the powers needed by the patient, this can also be beneficial. An additional cylinder correction is not possible with this lens due to the spherical front surface.
- **Bitoric compens.:** This lens type has both a toric back and a toric front surface. The induced astigmatism that the back of this contact lens would cause, is included on the front surface of the contact lens as a cylinder. As the induced astigmatism is neutralized by the front surface, this type of contact lens corrects the corneal astigmatism like a spherical contact lens, but the toric back surface also allows better stability of the lens on the eye to be achieved. Due to the neutralization of the induced astigmatism, the power of this contact lens does not depend on its rotation (inclination). An additional cylinder correction is not possible with this lens type either. As the refractive index n is not needed for bitorically compensated lenses, the field n and the material selection field are disabled.
- **Bitoric:** Bitoric lenses also have a toric back and a toric front surface. The axis positions of the two surfaces are independent of each other. The back surface torus can thus be determined first, purely for fitting purposes, and then the necessary front surface torus and its axis position can be calculated from the over-refraction. The calculation of bitoric contact lenses must be done by the contact lens manufacturer, therefore the field "Sph. (D):" is also disabled here.
- ➔ After selecting the contact lens type, press the [Suggestion] button. You are then given the optimal test lens for this contact lens type.

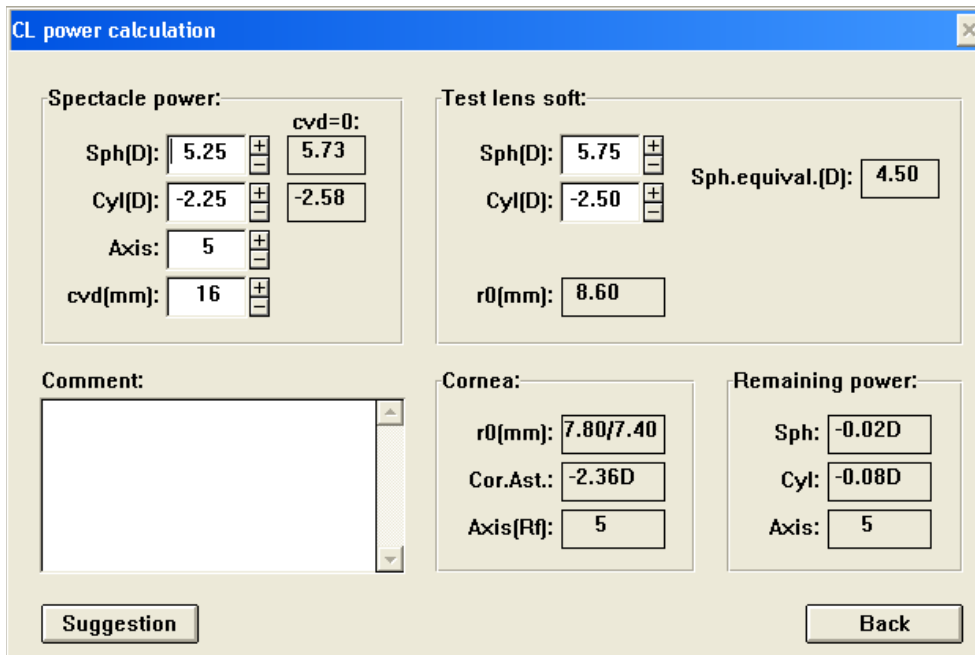


Note

After the [Suggestion] button has been pressed, the contact lens type is not changed, i.e. this function does not suggest a type of contact lens, but simply determines the optimal test lens based on the manually selected contact lens type.

4.2.7 Calculation of the Power for Soft Lenses

Calculation of the power of soft lenses is generally easier as a tear-lens is not produced.



The window titled "CL power calculation" contains the following fields and buttons:

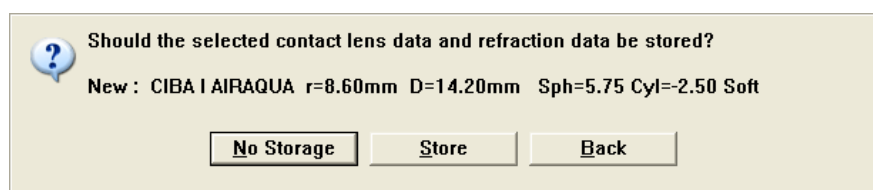
- Spectacle power:**
 - Sph(D): 5.25 (with +/- buttons) and cvd=0: 5.73
 - Cyl(D): -2.25 (with +/- buttons) and -2.58
 - Axis: 5 (with +/- buttons)
 - cvd(mm): 16 (with +/- buttons)
- Test lens soft:**
 - Sph(D): 5.75 (with +/- buttons)
 - Cyl(D): -2.50 (with +/- buttons)
 - Sph.equival.(D): 4.50
 - r0(mm): 8.60
- Comment:** A text area for notes.
- Cornea:**
 - r0(mm): 7.80/7.40
 - Cor.Ast.: -2.36D
 - Axis(Rf): 5
- Remaining power:**
 - Sph: -0.02D
 - Cyl: -0.08D
 - Axis: 5
- Buttons: "Suggestion" and "Back".

Fig. 4-13: Power calculation module for soft lenses

The power calculation module first calculates the powers at a cvd=0 and then transfers the rounded values into the "Test lens soft" box. To calculate the expected remaining power of this contact lens, the axis position of the spectacle power is used.

4.2.8 Saving and Loading the Fitted Contact Lens

- Press the [Back] button to exit the "Contact lens data" screen. A confirmation dialog box appears, in which the contact lens data are summarized and displayed again.



The dialog box contains the following information:

- Question: "Should the selected contact lens data and refraction data be stored?"
- Summary: "New: CIBA I AIRAQUA r=8.60mm D=14.20mm Sph=5.75 Cyl=-2.50 Soft"
- Buttons: "No Storage", "Store", and "Back".

Fig. 4-14: Confirmation dialog box for saving the contact lens data

- Press the [Back] button to resume the contact lens fitting process and e.g. to select a different contact lens.
- Press the button [Keep old data] to exit the contact lens fitting program without saving the selected contact lens.
- Press the button [Store new data] to save the contact lens and the power data.

When you have saved the contact lens fitting data for the patient, they are automatically loaded the next time the contact lens fitting program is called up. The data fields thus now contain the data for a fitted contact lens and not just a recommendation. Therefore, the blue highlight bar does not appear in the list of suggested lenses.

- Press the button [Calc fluo.] to re-generate the fluo image. This is **not** saved along with the contact lens data.

- If you then change the contact lens and power parameters, a confirmation dialog box appears when you exit the contact lens fitting program.
- Decide whether you want to save the new data or whether you want to keep the old data.

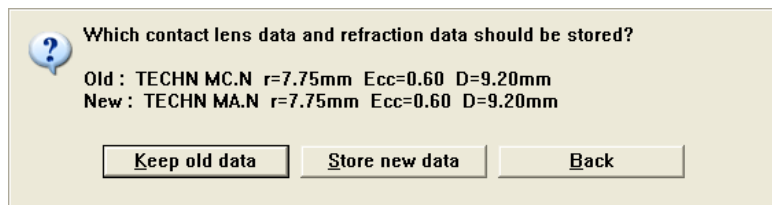


Fig. 4-15: Confirmation dialog box that appears after the contact lens data have been changed

5 Imaging

The imaging software is used to record videos and capture images. You can thus compare video recordings and images with the fluo image simulation of the measured eye.

5.1 Ordering the Imaging Software

Note

If you purchased the imaging software when you bought the keratograph, you do **not** need to order the software again. Then simply set up the imaging software accordingly ([sect. 5.2, page 90](#)).



In the appendix of the Operating Manual you will find a fax order form for ordering the optional imaging software, if you didn't already purchase it when you bought your keratograph. To order the software, you will need the serial number and the so-called "Device Code" of the keratograph.

- Take your keratograph's eight digit serial number SN that is printed on the OCULUS label on the power pack or on the head of the keratograph and write it on the fax order form.
- Open / start the Keratograph software ([sect. 3.1, page 22](#)).
- Click on the blue menu bar OCULUS - KERATOGRAPH to activate it.

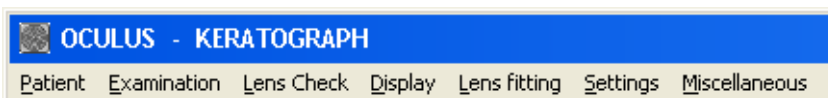


Fig. 5-1: Menu bar of the keratograph software

- Enter the four letters **lusm** "into the blank space".
- The following dialog box appears showing the Device Code for your keratograph.

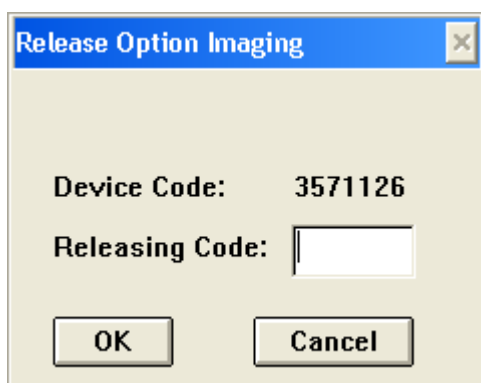


Fig. 5-2: Dialog box for activation of the imaging software

**Note**

Make sure that the communication between the PC and the keratograph is working properly. Otherwise the Device Code cannot be read out correctly.

- Also write this Device Code on the fax order form.
- Send the fax to the company OCULUS. The company OCULUS will then send you a document with the serial number of the unit, the device code and the releasing code (activation code) for the imaging software.

5.2 Activation and Setup of the Imaging Software

If you purchased the imaging software later, you must first activate it with the releasing code for your keratograph.

**Note**

If you already purchased the imaging software when you bought the keratograph, you do **not** need to activate the software.

- Open the imaging software activation dialog box in the manner already described ([sect. 5.1, page 89](#)).
- Enter the release or activation code that you received from the company OCULUS into the "Releasing Code" field.
- Confirm your entry with the [OK] button.

Finally, you must set up the imaging software. The necessary steps for doing so are done on the "Settings" screen.

- Select the menu "Settings" ([sect. 7, page 105](#)).

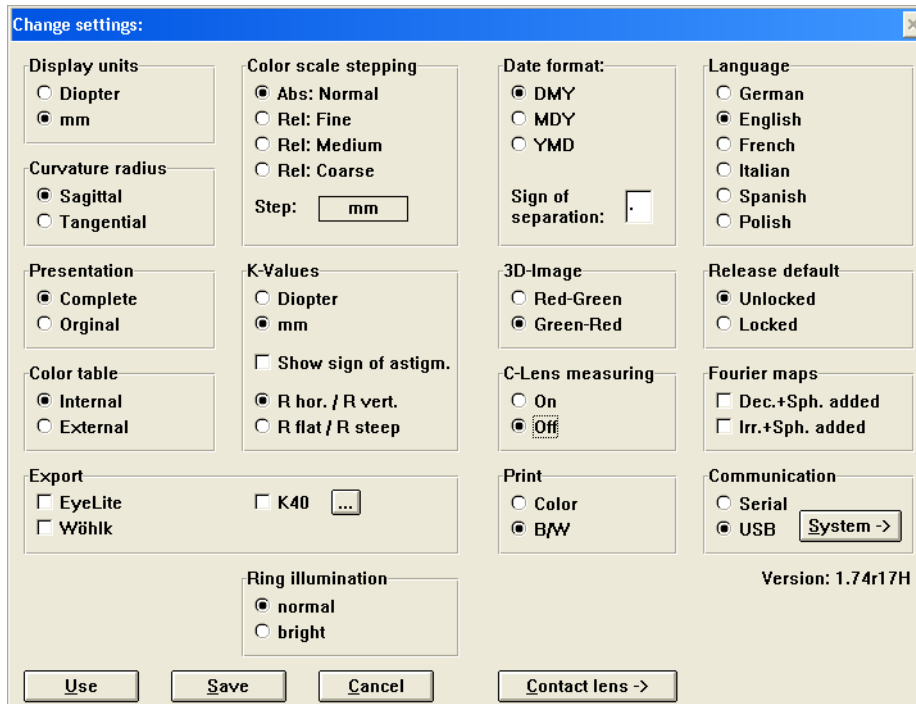


Fig. 5-3: "Change settings" screen

- ➔ Press the button [Video ->] on the "Change settings" screen. The "Select Code" dialog box appears.

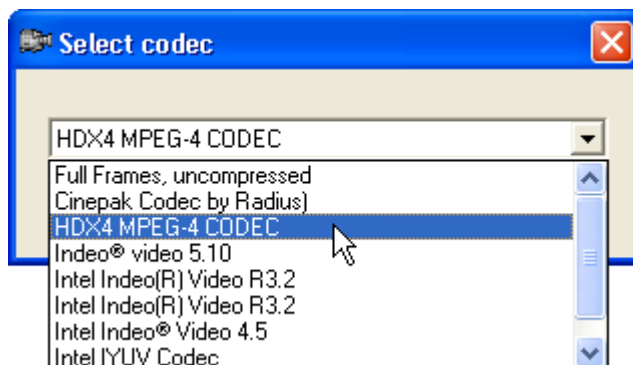


Fig. 5-4: "Select Code" dialog box

- ➔ Select the desired code from the list.

Note

Messrs. OCULUS recommends the code "HDX4 MPEG-4 CODEC".



- ➔ Close the "Select Code" dialog box.
 - ➔ Apply the setting by pressing the [Save] button on the "Change settings" screen.
- The imaging software is now ready for use.
- ➔ Open the menu "Examination". The new menu item. [New examination (Imaging)] is now present here.

5.3 Loading of Videos or Individual Images

You can load videos or individual images, as well as other examinations ([sect. 3.2, page 27](#)). For each examination it is shown whether it is a standard topographic measurement (no entry), a captured image (grab image), or a video sequence. The text that was entered in the info text field appears after that.

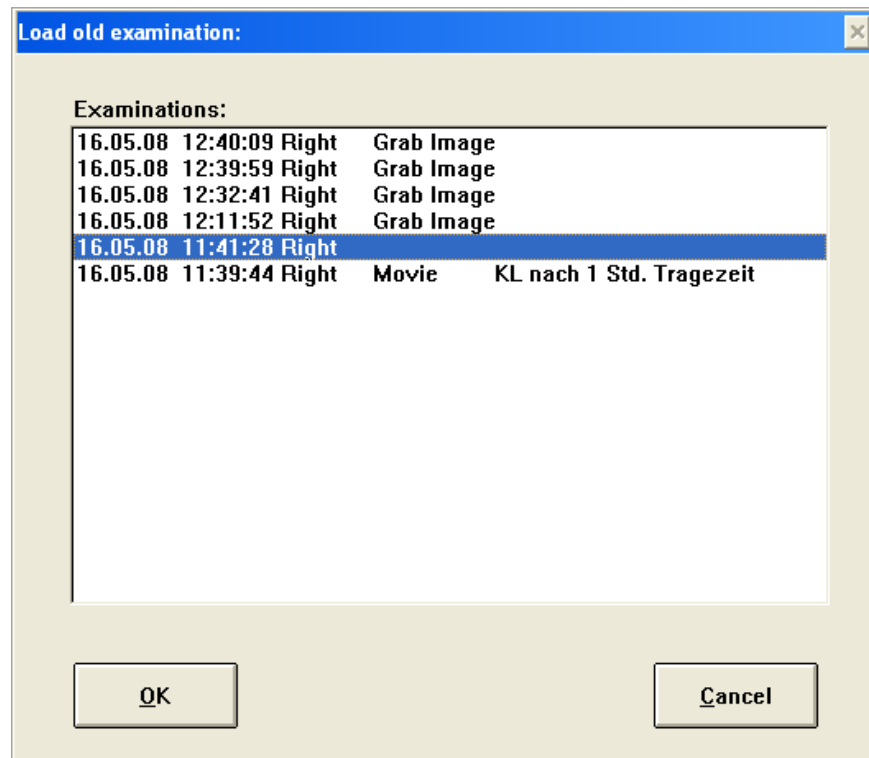


Fig. 5-5: "Load old examination" dialog

- ➔ Select an examination with image data or a video sequence.
- ➔ Press the [OK] button. The following screen displaying the overview of the selected examination appears.

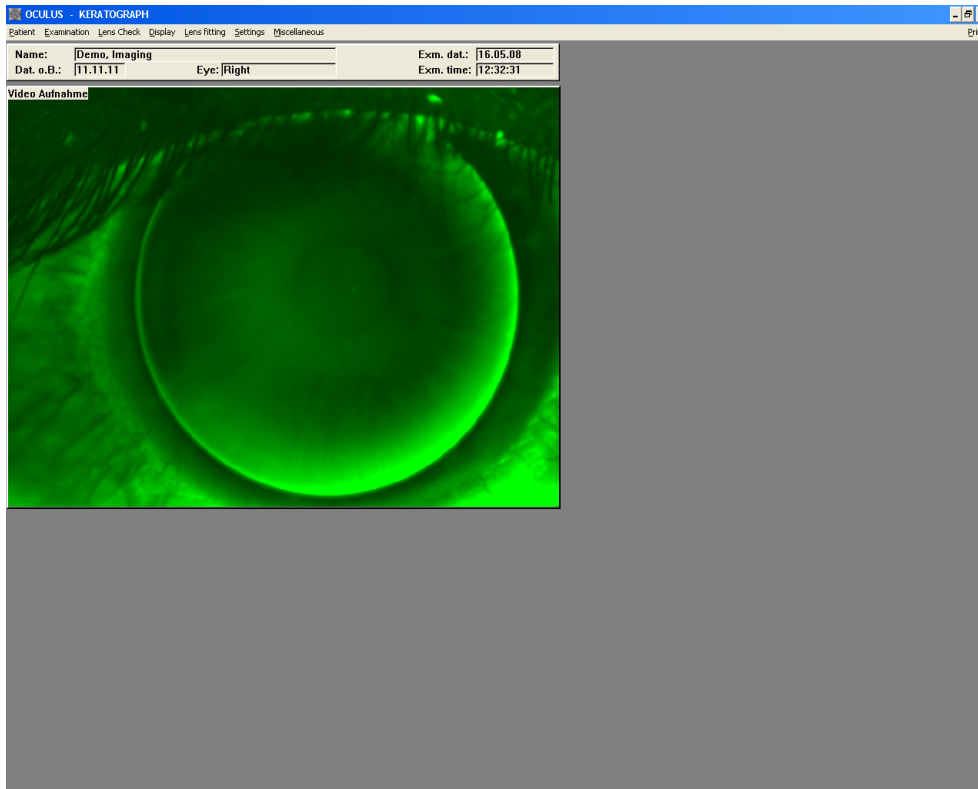


Fig. 5-6: Overview of a captured image

5.4 Comparing a Fluo Image Simulation and a Video

You can also compare a video or a single captured image with the fluo image simulation.

- ➔ Load a keratograph measurement ([sect. 3.2, page 27](#)).
- ➔ Select the menu item [Contact lens fitting] ([sect. 4, page 73](#)).
- ➔ Activate the option "Fluo image" in the "Display" box of the "Contact lens fitting" screen to generate a fluo image simulation.
- ➔ Then press the [Video] button. Instead of the "Contact lens fitting" screen, the stored videos and images are shown as a thumbnail view.

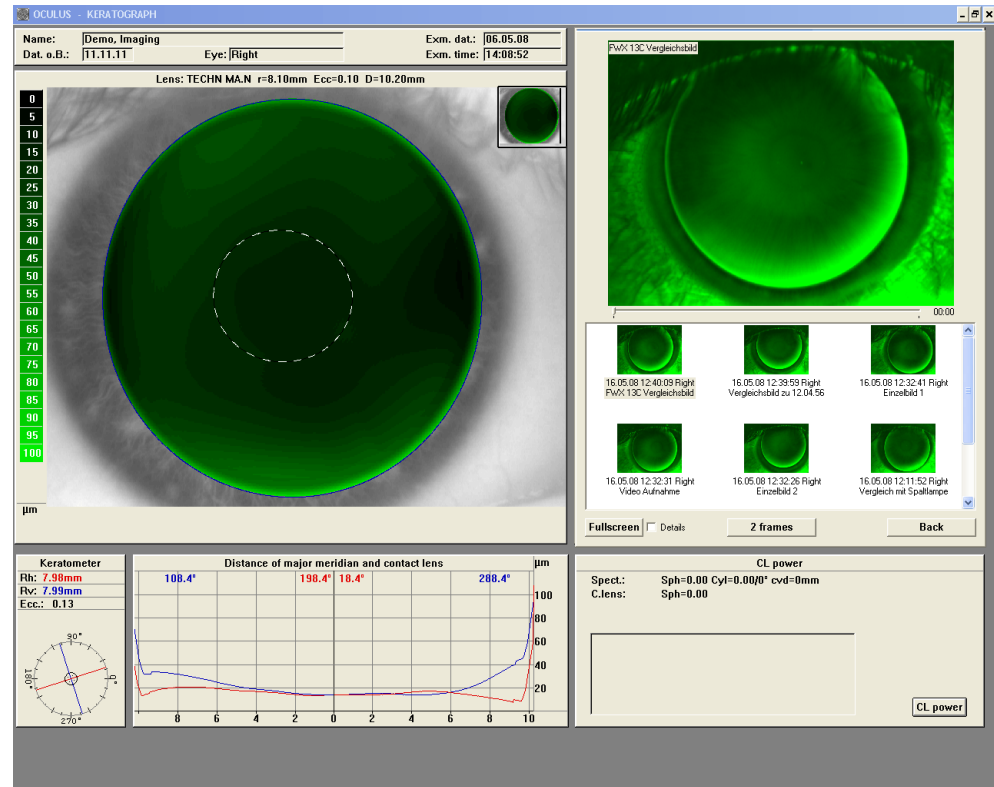


Fig. 5-7: Fluo image simulation after activating the [Video] button

5.4.1 Identification of Images and Videos

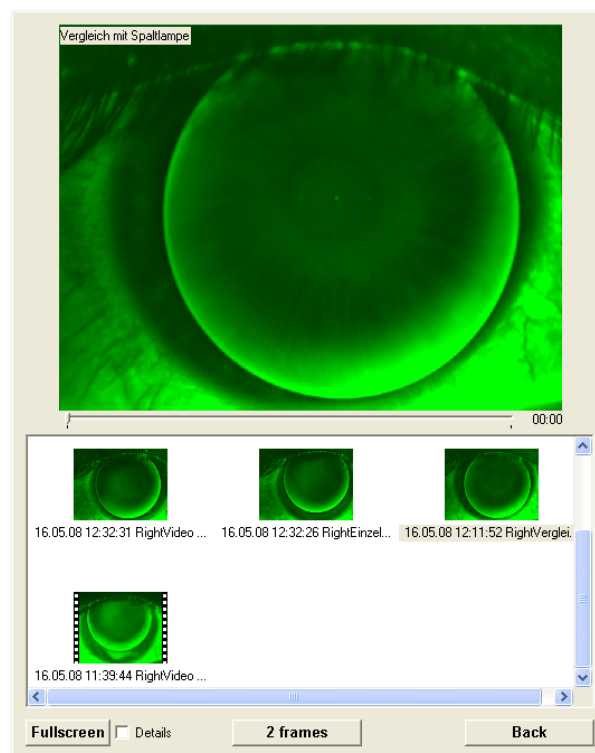


Fig. 5-8: Thumbnail view

The following information is given below each thumbnail for each video or image:

- Date

- Time
- Examined eye (left or right)
- Informational text, if any was entered

You can tell from the thumbnail itself whether it is a single image or a video sequence. Video sequences have "filmstrips" at the left and right sides of the thumbnail. A zoomed view can also be selected instead of the thumbprint view.

- ➔ Select the desired image or video by double-clicking it in the table. The corresponding image or video is displayed in the top section of the screen.
- ➔ You can activate the checkbox [Zoom] at option. The thumbprints are then hidden and a table containing the above-mentioned information appears instead. In addition, the "Type" column specifies whether it is an image or a video sequence.

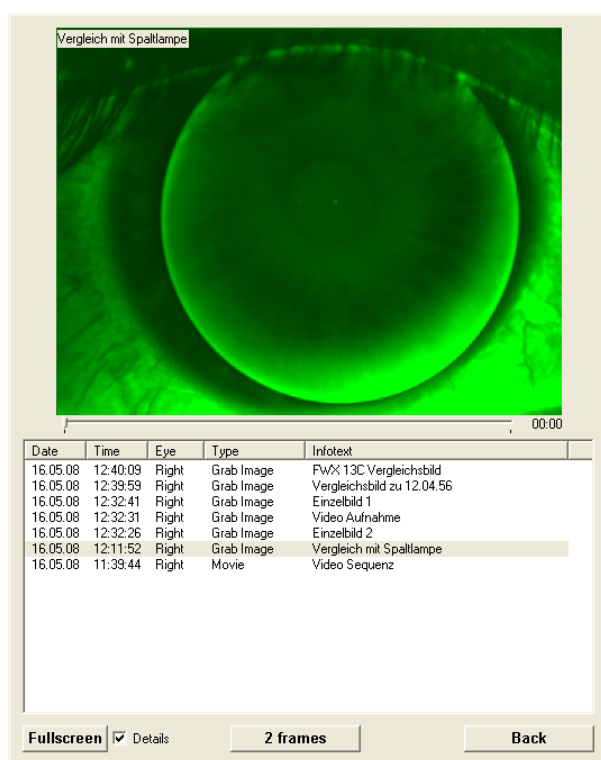


Fig. 5-9: Zoom view

Note

The assignment of an informational text is done the same way as for camera images (sect. 3.1.5, page 25).



5.4.2 Adjusting the display

- ➔ Press the button [Full screen] to get a full-screen display of the individual image.

**Note**

This function does not apply to video recordings.

- To play the video sequences, press the  button, or press the  button to pause.
- Press the button [Zoom in] to compare two video sequences or two individual images with each other.
- Select the first image or first video sequence in the thumbprint or in the zoom view. This is then shown in the bottom section.
- Select the second image or the second video sequence. This is now shown in the bottom section and the previously selected image or video sequence "moves" to the top section.

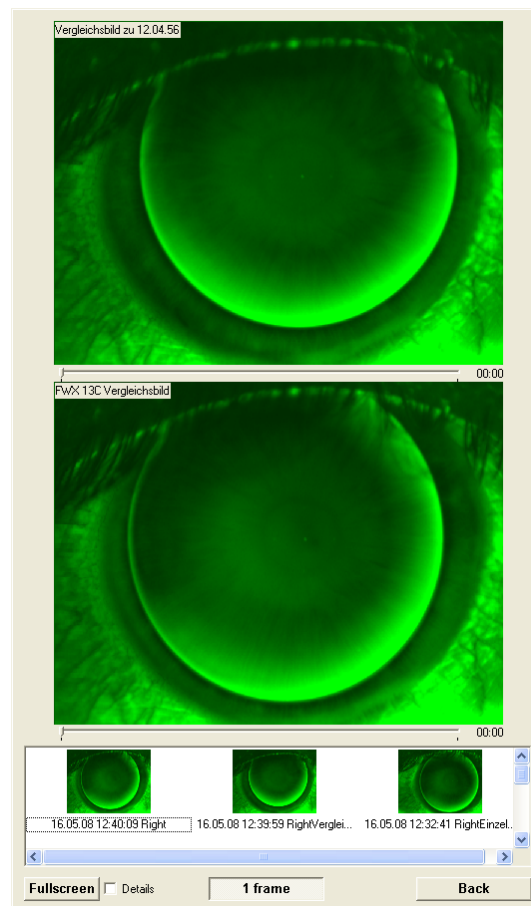


Fig. 5-10: Comparison of two individual images

**Note**

The image or video sequence that was loaded last is always displayed in the bottom section of the screen.

6 Pupillometer Software

The pupillometer software enables you to conduct pupillometric or pupillographic examinations with the keratograph. The pupil size is thereby measured continuously (within a certain time frame) and is displayed on a time basis. The pupil is illuminated with infrared light for measurement purposes. The pupil size can also be determined in the darkness adaption state. The keratograph also offers the option of switching two glare sources of different stimulus intensities on or off, thus enabling you to measure the pupil reaction to these glares. You can also compare the pupil reaction, e.g. of the right and left eye and calculate differential curves.

The optional pupillometry is available in the keratograph from software version 1.55 on and can be installed for all keratographs from the model Keratograph 2 on (From model year approx. 1998 and later).

6.1 Ordering the Pupillometer Software

Note

If you purchased the pupillometer software when you bought the keratograph, you do **not** need to order the software again. Then simply set up the pupillometer software accordingly ([sect. 6.2, page 98](#)).



In the appendix of the Operating Manual you will find a fax order form for ordering the optional pupillometer software, if you didn't already purchase it when you bought your keratograph. To order the software, you will need the serial number and the so-called "Device Code" of the keratograph.

- Take your keratograph's eight digit serial number SN that is printed on the OCULUS label on the power pack or on the head of the keratograph and write it on the fax order form.
- Open / start the Keratograph software ([sect. 3.1, page 22](#)).
- Click on the blue menu bar OCULUS - KERATOGRAPH to activate it.

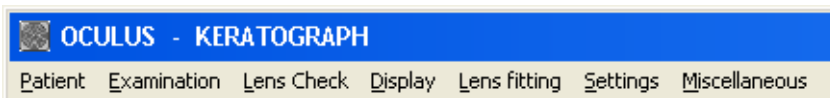


Fig. 6-1: Menu bar of the keratograph software

- Enter the four letters **lusp** "into the blank space".
- The following dialog box appears showing the Device Code for your keratograph.



Fig. 6-2: Dialog box for activation of the pupillometer software



Note

Make sure that the communication between the PC and the keratograph is working properly. Otherwise the Device Code cannot be read out correctly.

- Also write this Device Code on the fax order form.
- Send the fax to the company OCULUS. The company OCULUS will then send you a document with the serial number of the unit, the device code and the releasing code (activation code) for the pupillometer software.

6.2 Activation and Setup of the Pupillometer Software

If you purchased the pupillometer software later, you must first activate it with the releasing code for your keratograph.



Note

If you already purchased the pupillometer software when you bought the keratograph, you do **not** need to activate the software.

- Open the pupillometer software activation dialog box in the manner already described ([sect. 6.1, page 97](#)).
 - Enter the release or activation code that you received from the company OCULUS into the "Releasing Code" field.
 - Confirm your entry with the [OK] button.
- The pupillometer software is now ready for use.
- Open the menu "Examination". The new menu item. [Pupillometer] is now present here.

6.3 Setting the Camera Brightness

The keratograph's infrared illumination differs from unit to unit. The software can therefore be adapted to the differing brightnesses.

Note

The brightness can only be changed in the "Overview" screen, or after a pupillometer examination has been loaded.



- Make sure that a connection to the keratograph has been established.
- **Similar** to the process for activating the pupillometer software, type in the letters **lusP** (i.e. "l" "u" "s" in lower case and "P" in upper case, i.e. capital P = Shift + p).

Note

When activating the pupillometer software, you enter **all** letters in lower case, but when setting the camera brightness, the final "P" must be entered in upper case (capital letter).



Select the desired camera brightness in the dialog box that then appears.

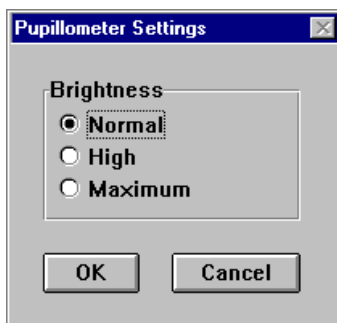


Fig. 6-3: Selecting the camera brightness

→ Select the setting "Normal" if possible.

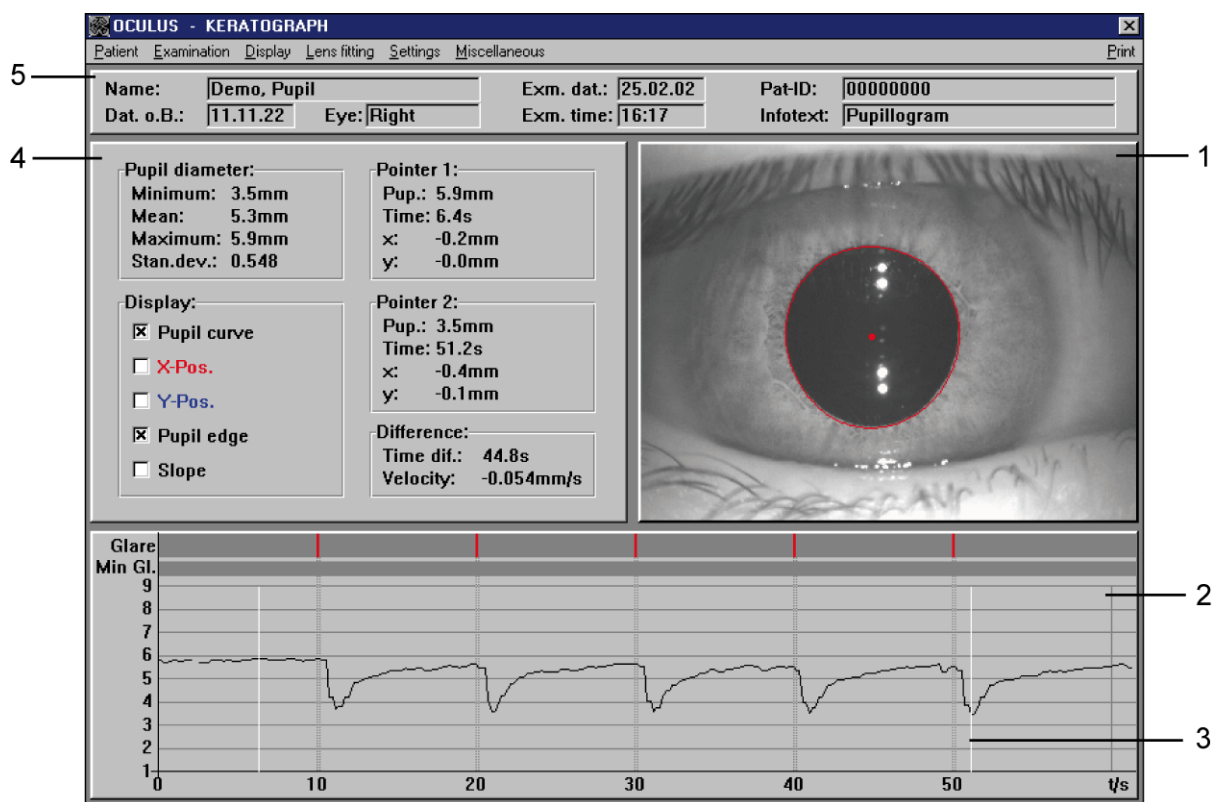
If you have to select the setting "High" or "Maximum", for technical reasons, for measurements done with the Placido ring illumination switched on ("Glare"), the illumination must be switched off briefly. This causes the Placido illumination to flimmer during the glare process. This does not, however, apply for the less intense glare (inner ring).

**Note**

- Changes made to the brightness are permanently stored and therefore only need to be made once.
- The selected brightness has no effect on the serviceable life of the camera, as only the exposure times are changed.

6.4 Pupillometry Overview Screen

All analysis information is summarized in the overview screen to give you a quick overview of the measured pupillometric data.



1 Scaled down camera image

2 Time scale

3 Indicator line

4 Data field

5 Patient and examination data

Fig. 6-4: Pupillometry Overview Screen

6.4.1 Patient and examination data

Name:	Demo, Pupil Anisokorie	Dat. o.B.:	11.11.21	Infotext:	Anisokorie test
Examination A:	01.03.02 11:17:00 Right	Pointer 1:	2.7mm	Pointer 2:	6.5mm

Fig. 6-5: Patient and examination data

Just like in the overview screen for a topography examination, the most important patient and examination data are displayed in this individual map (4) ([sect. 3.1.1, page 22](#)).

- Last name and first name
- Date of birth
- Eye examined
- Examination date and time

Additionally, the following is displayed:

- **Pat-ID:** Patient ID, as assigned in the patient data management system
- **Info text:** The name of the program with which the measurement was performed appears in this box by default ("Pupillogram" or "Anisocoria test"). You can change the text to anything you like by clicking in the field.

6.4.2 Scaled down camera image

Just like in the overview screen of a topography examination, a scaled-down camera image (1) of the examination is displayed. However, there is no measuring function in the pupillometry and an informational text or comment cannot be entered here. The zoom function is activated by default ([sect. 3.9.1, page 66](#)):

- ➔ Move the mouse to the desired place in the camera image and click the left mouse button.
- ➔ A zoomed-in view of the section of the camera image around the position at which the mouse is located is displayed in a separate window for as long as you hold down the mouse button.
- ➔ Press the right mouse button to cancel the zoomed-in view again.

6.4.3 Data field

Some information about the measurement are listed in the left hand section of the screen (3). These numeric values relate in part to the graph in the bottom section of the screen ([sect. 6.4.4, page 102](#)).

"Pupil diameter" box

- **Smallest:** Smallest measured pupil diameter in mm
- **Mean:** Mean or average pupil diameter in mm
- **Largest:** Largest measured pupil diameter in mm
- **Std.dev.:** Calculated standard deviation

Note

These values are only meaningful for measurement of the pupil stability, i.e for measurement **without** glare.



"Display" group box

You can display or hide additional information in the time scale graph of the measured pupil diameter and in the camera image by activating or deactivating these checkboxes accordingly.

- **Pupil curve:** Display (activate) or hide (deactivate) the whole time scale graph of the measured pupil diameter ([sect. 6.4.4, page 102](#))
- **X. Pos. and Y. Pos.:** Display or hide the curves of the X- and Y- position of the center of the pupil in the graph. These curves provide an indication for any eye movements of the patient.
- **Pupil (Camera Image):** Display or hide the red outline around the pupillary margin in the camera image.
- **Slope:** Display or hide the speed vector in the graph. The two relocatable measured values are interconnected. The slope of the connecting line equates to the speed of the change in the pupil.

"Indicator 1", "Indicator 2" and "Difference" box

Two white indicators can be placed at any position in the time scale graph of the measured pupil diameter ([sect. 6.4.4, page 102](#)). The following information is displayed for each of these two positions:

- **Pup.:** Actual pupil diameter in mm
- **Time:** Time that has elapsed since the start of the measurement in seconds
- **x and y:** X- and Y- position of the center of the pupile with respect to the center of the camera.

The differences for the following values between the two indicators are displayed in the "Difference" box:

- **Time diff.:** Time difference between the positions of the indicators in seconds
- **Speed:** Average speed of the pupil change in mm per second. This is calculated by dividing the difference in pupil diameter by the above-mentioned time difference.

6.4.4 Time Scale of the Pupil Diameter

The pupil diameter time scale can be displayed in the bottom section of the screen (2) during the measuring operation. A section through the difference map is shown in a graph below the difference box.

The time in seconds is plotted on the abscissa (X axis) of this graph and the pupil diameter at the respective point in time is plotted on the ordinate (Y axis). The scale of the ordinate can be changed.

- ➔ Click on the ordinate with the mouse button. A selection box appears
- ➔ Select the desired scale (4 mm, 6 mm, 8 mm or 10 mm). The graph is resized accordingly.

You can also move two indicators (3) to any position in the graph.

- ➔ Do do this, click on an indicator with the mouse and, while holding down the mouse button, slide it to the desired position.
- ➔ Proceed in the same way for the second indicator. The corresponding values are updated accordingly in the data field ([sect. 6.4.3, page 101](#)).

6.5 Comparison View of the Pupillometry

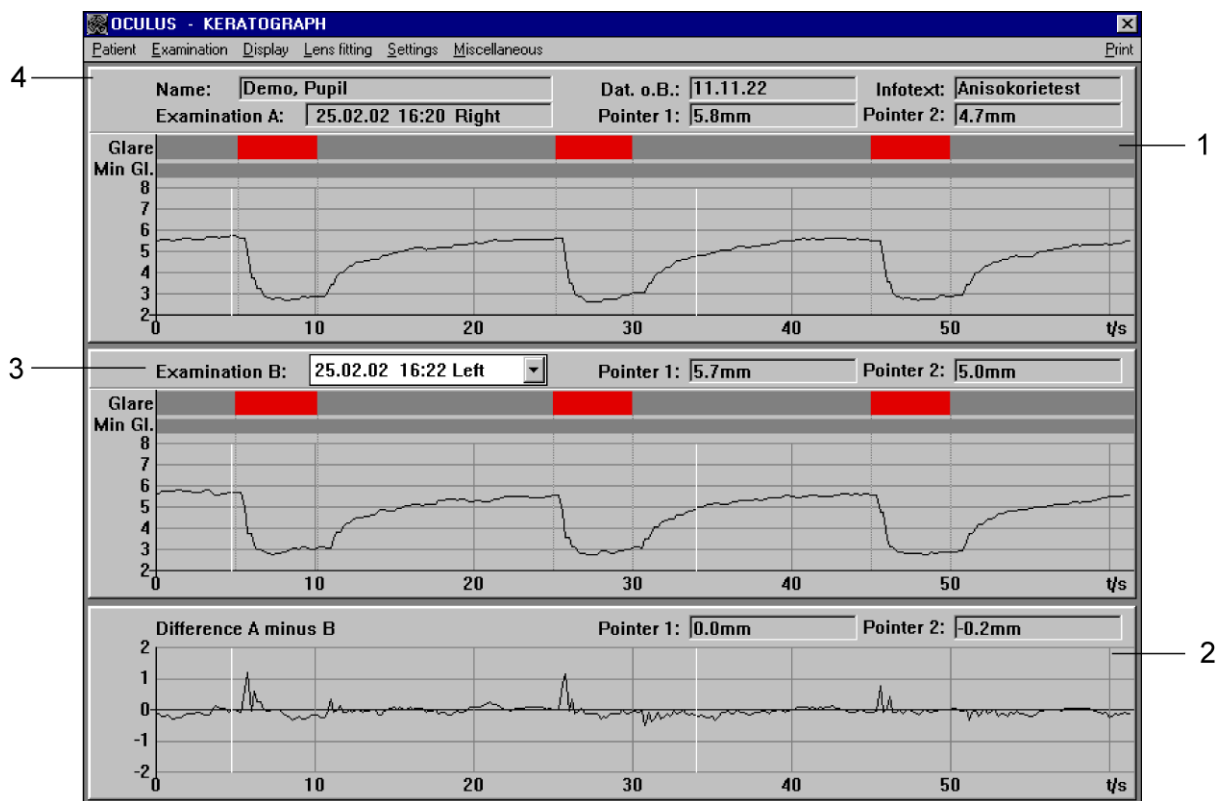
In addition to the patient and examination data (sect. 6.4.1, page 100), two pupillometric measurement time scales can be displayed here (sect. 6.4.4, page 102).

Note

This view is particularly beneficial for detecting anisocoria (unequal pupils). Therefore, first execute the automatic program "Anisocoria test".



- ➔ First load the examination (sect. 3.2, page 27) that is to be used as the basis (the minuend), e.g. the examination of the left eye.
- ➔ In the "Display" menu, select the menu item [Compare Examinations]. The following tab appears.



1 Examination A

2 Difference display

3 Examination B

4 Patient and examination data

Fig. 6-6: Display "Compare examinations"

- ➔ In the drop-down list "Examination B" (3), select the examination of which the results are to be subtracted (the subtrahend), e.g. the corresponding examination of the right eye.

A graph showing the difference is then displayed below the graph of the second examination. **Example:** If you select Examination A in the top graph and Examination B in the bottom graph, the difference Examination A - Examination B is output in the Difference graph.

Here again, two indicators can be placed at any position in the graphs. Movement of the indicators always affects all three graphs in equal measures.

6.6 Pupillometry Camera Image

- In the "Display" menu, select the menu item [Camera Image]. The camera image captured with the infrared light is displayed as a magnified view.

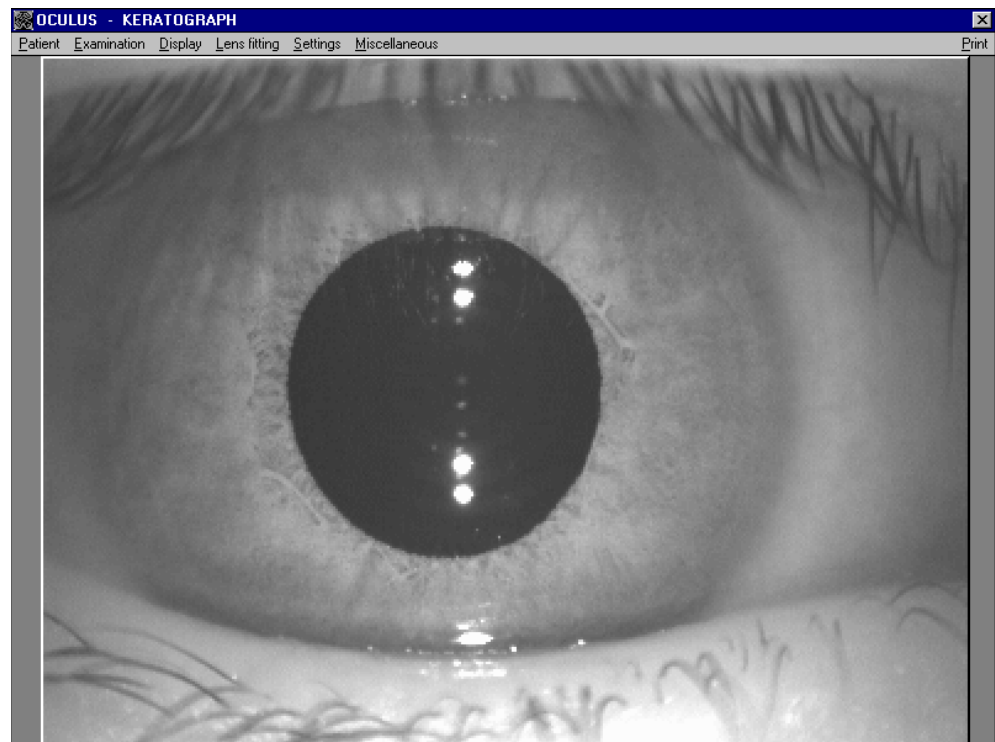


Fig. 6-7: Display "Camera image"

7 Settings

The basic settings for the Keratograph software can be made using the settings.

→ Select the menu "Settings". The "Change settings" page appears.

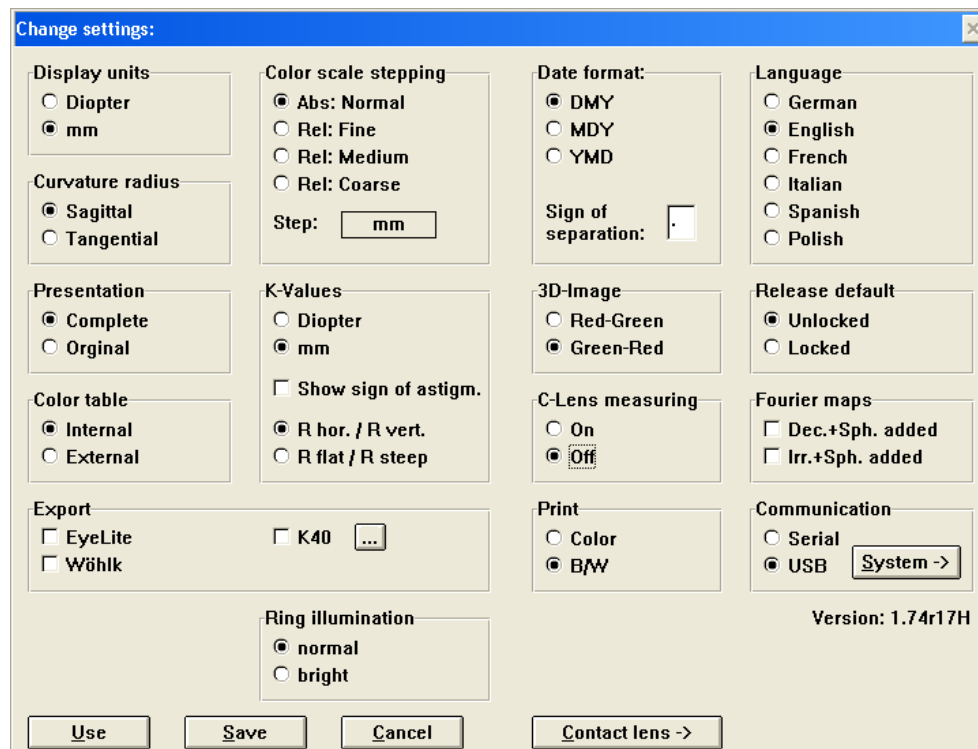


Fig. 7-1: "Settings" screen

After you have made all of the settings described below, you can close the screen again with the buttons at the bottom of the screen. The following options are available:

- **[Use] button:** The present settings are applied and are used until the keratograph software is exited and is subsequently restarted. The last settings that were saved are then used again.
- **[Save] button:** The present settings are applied and are saved. They are thus available even after exiting and restarting the keratograph software.
- **[Cancel] button:** None of the changes are applied. The settings that were last saved remain in effect.

Keratograph Software Version Number

The software version of the keratograph software is displayed at the bottom right of the "Change settings" screen.

→ Keep this number handy when consulting with OCULUS Service Department employees.

**Note**

The keratograph software version has nothing to do with the patient data management system software version ([sect. 2.6, page 9](#)) as these are two completely separate programs.

7.1 General Settings

You make all of the settings described below on the "Change settings" screen itself. In addition, depending on what software is installed on your keratograph, additional buttons are present, with which you can open other screens.

7.1.1 "Display units" settings

- ➔ Select whether you want the information displayed as a refraction power in diopters "D", or as a radius of curvature in mm "r". The following formula is used for conversion purposes:

$$D = \frac{(1,3375 - 1) \cdot m \cdot \text{dpt}}{r}$$

**Note**

The radius is entered in "meters" in the above-mentioned formula.

7.1.2 "Curvature radius" settings

In general, the display can be selected between the tangential curvature and the sagittal curvature. This setting relates to all displays in which the radii of curvature are output, e.g. "Overview" ([sect. 3.1.2, page 23](#)), "Color topography" ([sect. 3.2, page 27](#)), "3D view" ([sect. 3.3, page 29](#)), "Fourier Analysis" ([sect. 3.4, page 31](#)) etc. It does **not**, however, relate to the "Keratometer data" ([sect. 3.1.4, page 24](#)), "Color refractive map" ([sect. 3.7, page 58](#)), "Height data" ([sect. 3.8, page 60](#)) and "Lens Fitting" ([sect. 4, page 73](#)).

- ➔ Select whether you want the radii of curvature displayed as a tangential or as a sagittal curvature.

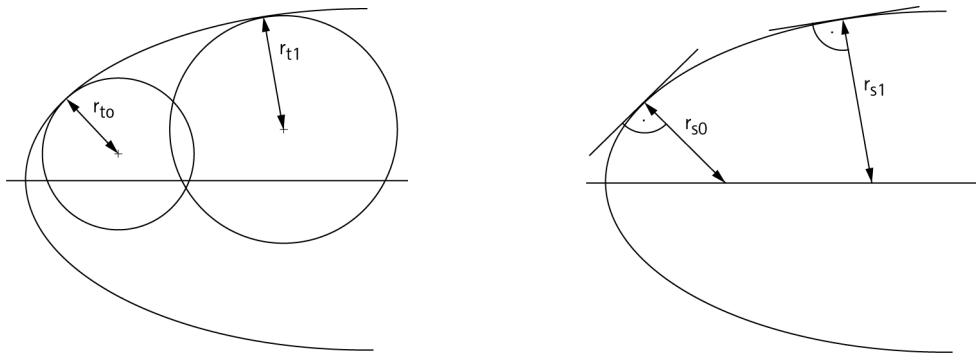


Fig. 7-2: Tangential curvature (left) and sagittal curvature (right)

The **tangential curvature** corresponds to the cornea curvature in the measuring point. In this display, corneal irregularities become more strongly recognizable.

The **sagittal curvature** corresponds to the length of one of the lots angled vertically to the tangent in the measuring point from measuring point until the point of intersection with the optical axis. In this display, the curvature value is dependent on the incline in the measuring point, and the relation to the optical axis is also important. For this reason, the sagittal display represents rather the optical effect of the cornea.

7.1.3 Settings "Presentation"

- ➔ Select how areas in the color maps that were not measured are to be displayed.
- **Complete:** Points that were not measured are interpolated and are marked with black dots.
- **Original:** Points that were not measured are **not** interpolated and are shown as white areas.

7.1.4 "Color table" settings

- ➔ Select the color table that is to be used for the color presentations.
- **Internal:** The internal color table used by OCULUS is used.
- **External:** An external color table is used.

If you simply want to compare the color presentations of the keratograph with the color presentation of other topographs, you should select the setting "External". You can then match the colors used on the keratograph accordingly. To do this:

- ➔ Open the file "TOPO.COL" in the "C:\TOPO" directory with a text editor.
- ➔ Now enter the number of the color grade in front of the colon (from 0 to 63).
- ➔ Enter the corresponding RGB color code after the colon.

Example:

00 : 252,252,252, 0

The RGB code "252, 252, 252" is used for the color grade "00". Black (= "0") is used for the color of text.

7.1.5 "Color scale stepping" settings

The color scale and thus also the color presentation can be displayed with different color scale steps ([sect. 3.1.2, page 23](#)).

- **Abs: Normal:** With this setting, each color always describes the same, permanently assigned value. In the middle area, the color bar has a resolution of 0.20 mm. Below 6.6 mm, the gradation is 0.4 mm, above 10.5 mm, the gradation is 6 mm.
- **Rel: Fine:** With one of the three relative settings, the middle of the color scale corresponds to the mean radius of curvature of the front of the cornea. When the option "Rel: Fine" is activated, the color bar has a resolution of 0.05 mm or 0.25 dpt.
- **Rel: Medium:** This setting is more or less the same as the "Rel: Fine" presentation. Here, however, the color bar has a resolution of 0.10 mm or 0.5 dpt.
- **Rel: Coarse:** This setting is also more or less the same as the "Rel: Fine" presentation. Here, however, the color bar has a resolution of 0.20 mm or 1.0 dpt.



Note

The selected settings are also output below the color scale.

7.1.6 Settings "K-Value Presentation"

The settings in this box relate to the presentation of the keratometric data ([sect. 3.1.4, page 24](#)).

- ➔ Select whether the central radii (Rh and Rv or Rf and Rs) are to be displayed in the overview in mm or in diopters.
- ➔ Deactivate the checkbox [Show sign of astigm.] to display the astigmatism without preceding algebraic sign (as a vector).

If the checkbox [Show sign of astigm.] is activated, the following applies:

- **Preceding sign +:** $R_v > R_h$ (inversus)
- **Preceding sign -:** $R_v < R_h$ (rectus)
- ➔ Select whether the horizontal and the vertical radius (option [R hor./R vert.] is activated), or the flat and the steep centra radius (option [R flat./R steep] is activated) are to be displayed

7.1.7 "C-Lens measuring" settings

- ➔ Activate the "On" option if you want to measure the back surface of the contact lenses. The additional menu "Lens Check" with the menu item "Back surface" appears in the menu bar.

7.1.8 Settings "Export"

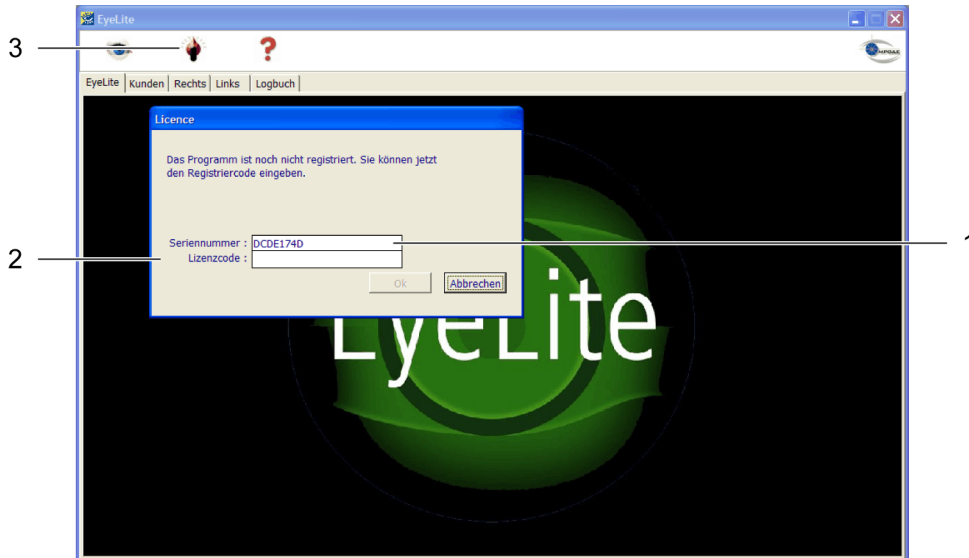
Using these options, fitting programs for contact lenses from different manufacturers can be embedded into the keratograph software.

Checkbox "EyeLite"

A special fitting program from the company MPG&E is available for fitting MPG&E/Mueller-Welt contact lenses. You can obtain this program free of charge from MPG&E. When

this program is used, the fitting rules of the company MPGET are applied to generate a suggestion of which contact lenses to use based on the measured corneal geometries.

- First install the program "EyeLite".
- Then open the "EyeLite" program. A dialog box appears for input of a licence code.



1 "Serial number" field

3 [Settings] button

2 "Licence code" field

Fig. 7-3: Request for the licence code for the EyeLite software

- Call the company MPGET's fitting help desk at the number 04322 750-500 and ask for the free licence code. Have the serial number of the EyeLite software (1) ready at hand.
- Enter the licence code into the appropriate field (2) of the EyeLite software.
- Confirm your entry with the [OK] button.
- Press the [Settings] button (3).
- Activate the "Topograph" tab panel.

The following screen appears:

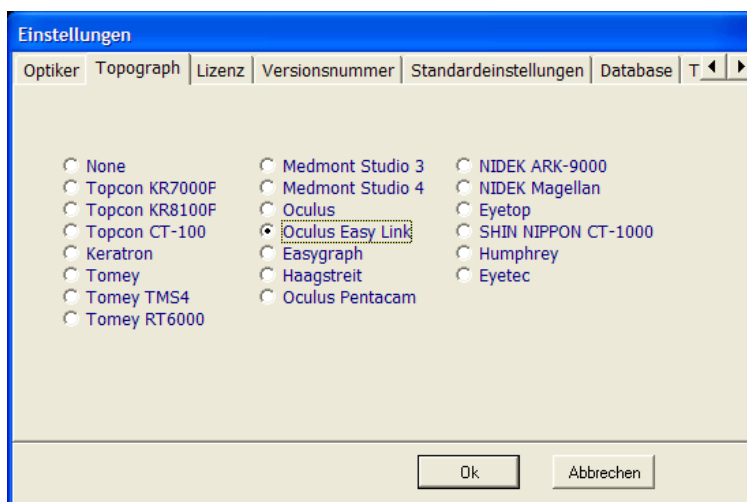


Fig. 7-4: "Settings" screen of the EyeLite software

- Activate the checkbox [Oculus Easy Link].

- ➔ Finally activate the checkbox [EyeLite] in the "Export" box of the keratograph software.

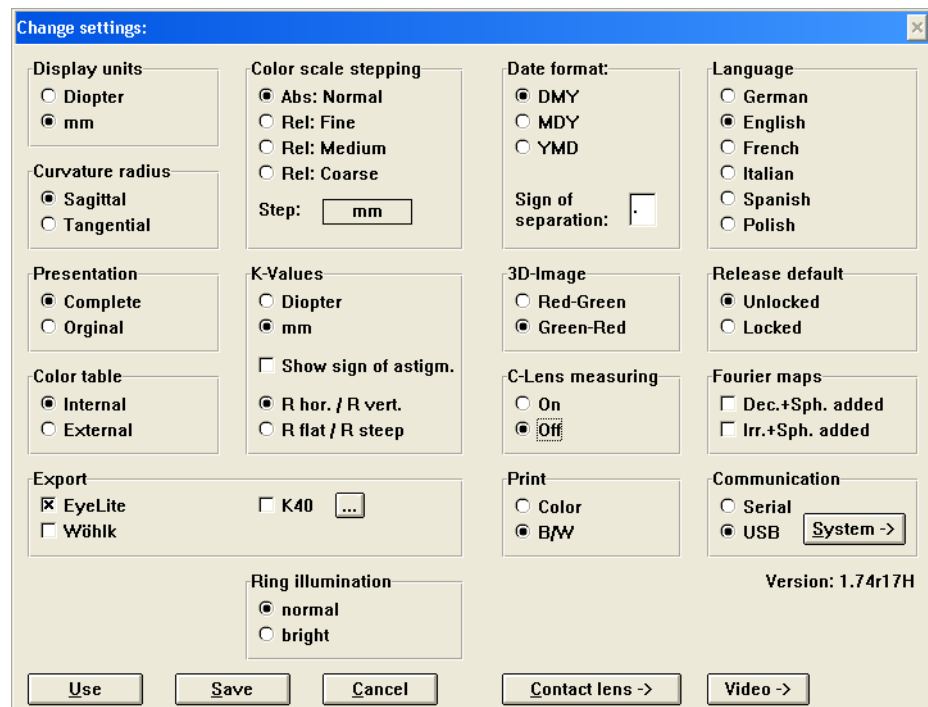


Fig. 7-5: "EyeLite" checkbox activated on the "Change settings" screen

You can now access the "EyeLite" fitting program via the "EyeLite" menu item in the "Miscellaneous" menu.

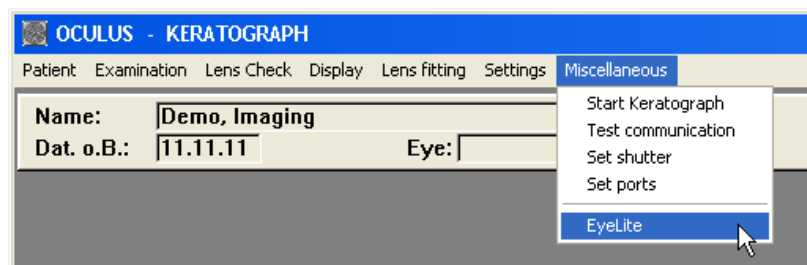


Fig. 7-6: Calling the "EyeLite" fitting program

"Wöhlk" checkbox

An interface to a fitting program of the company Wöhlk is presently in the works.

[K40] checkbox

The interface can only be used by Care Vision (Laser clinic).

- ➔ Activate the checkbox [K40] if applicable.

7.1.9 Settings "Date"

- ➔ Select the format for display of the date. You can choose any of the following formats:
 - **DMY:** Day - Month - Year, e.g. 11.07.2008
 - **MDY:** Month - Day - Year, e.g. 07.11.2008

- **YMD:** Year - Month - Day, e.g. 2008.07.11
- ➔ Select the sign of separation that you want to appear between the day, month and year. The default setting here is a period (full stop) (".").

7.1.10 Settings "3D-Image"

- ➔ Match the grid for the 3D-presentation to the 3D-spectacles that are being used.
- **Red-Green:** The red lens is on the left, the green lens on the right.
- **Green-Red:** The green lines in on the left, the red lens on the right.

7.1.11 "Print" settings

The presently displayed screen can be printed out on a connected printer by activating the "Print" menu item in the menu bar of the keratograph software.

- ➔ Select whether the screen page background is to be printed out in "B/W" or in "Color".

7.1.12 "Ring illumination" settings

Note

You can only make settings here when the "USB" option is activated in the "Communication" box.



-
- ➔ Select whether you want normal ring illumination or extra bright illumination. The [bright] setting is recommended for examining patients with very dark eyes.

7.1.13 Settings "Language"

- ➔ Select the language in which the user interface of the keratograph software is to be displayed.

7.1.14 "Release default" settings

- ➔ Select whether initiation of the measurement is to be activated by default (setting "Unlocked") after the menu item "New examination (eye)" has been activated in the "Examination" menu.
- ➔ If you select the "Locked" setting, you must press the spacer bar after activating the respective menu item to activate automatic initiation of the measurement.

Note

If the appropriate optional software module is installed for your keratograph, this setting also applies for the menu items "New Examination (Near vision height)" and "New Examination (Lid angle)".



7.1.15 "Fourier maps" settings

- Activate the respective checkboxes if the decentration and irregularities of the spherical part are to be added in the Fourier map presentations.
"Dec.+Sph. added" or "Irr.+Sph. added" then appears in the title bar of the respective presentation accordingly.

7.1.16 "Communication" settings

- Select whether the connection between the PC and the keratograph is established via a serial interface (COM port) or a USB port.
The configuration of selected interface is done on the "Change system settings" screen ([sect. 7.2, page 112](#)).

7.2 System settings

Different settings must be made depending on the selected interface type ("Communication" box).

- Press the [System ->] button.

7.2.1 Serial interface port

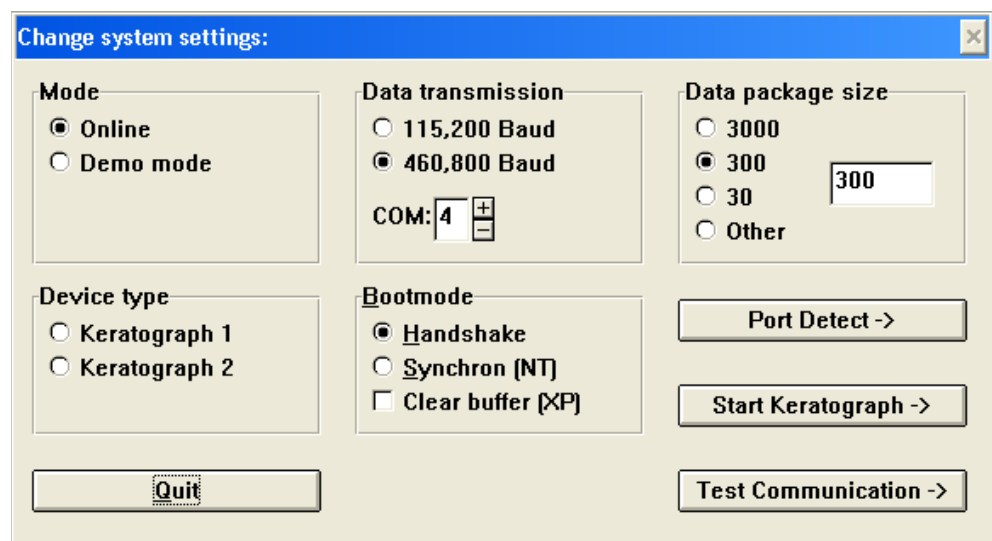


Fig. 7-7: "Change system settings" screen for the serial interface

"Mode" settings

- Select the option "Demo mode" to be able to use the keratograph software without the unit being connected.
- If you want to perform measurements, you must select the option "Online".

"Device type" settings

- Select the keratograph type that is installed.

Note

For the device type "Keratograph 2", the inner ring flashes **twice** after switch-on



"Data transmission" settings

- In the "COM" field, select the COM port to which the keratograph is connected.
- Depending on the PC card that is installed, select the data transmission rate for the communication between the PC and the keratograph.

Note

The default setting for the communication ports COM1 and COM2 is 115,200 Baud.



"Bootmode" settings

The boot process takes place when the keratograph is switched on. In general, authentication is awaited after each byte has been transmitted. You can select one of the following settings.

- **Handshake:** The next byte is transmitted **immediately** after authentication.
- **Synchron (NT):** After authentication, the next byte is transmitted after a constant time period has elapsed. This setting slows down the boot process to 10 seconds (as opposed to 6 seconds in "Handshake" mode). "Handshake" However, this provides greater transmission reliability.

Note

The setting "Synchron (NT)" **must** be selected if Windows NT is being used as the operating system.



- Preselect the desired boot mode for switch-on of the keratograph.
- If you use Windows XP as your operating system, activate the checkbox [Clear buffer (XP)].

"Data package size" settings

From software version 1.38 on, an error correction is performed for the data transmission. This is necessary because Pentium 2 PCs do not provide stable data transmission, especially when Windows 98 is being used as the operating system on the PC.

For error correction purposes, the data are transmitted as packages, which, in the event that an error has occurred, are transmitted again. In the event of an error, the data transmission rate is reduced accordingly.

- ➔ Select the desired data package size from the available options "30", "300" and "3000", or enter any package size between 30 and 3000.
- ➔ When selecting the package size, heed the following information.
 - The bigger the package, the less often the data have to be transmitted for the package test. If errors generally occur only rarely, the transmission is faster with this setting.
 - The smaller the package, the less data have to be transmitted in the event of an error. If a lot of errors generally occur, the transmission is faster with this setting.

Automatic Setting of the COM Port

You can automatically determine the parameters for the COM port to which the keratograph is connected and can take these over into the keratograph software. This is conditional upon the port being correctly set up in the Windows system control panel.

- ➔ Plug the "OCULUS COM Port Detector" into the COM port at which the keratograph is normally connected.
- ➔ Press the [Port detect ->] button. The utility program starts and determines the appropriate settings.

Detect Interface for Keratograph 2

```

——— COM-Port detection ———
COM1 not available
COM2 Answer: No
COM3 not available
COM4 Answer: 128
COM5 not available
COM6 not available

Test COM4 : 128, 128, 128, 460,800 Baud

Result: COM4, 460,800 Baud

——— Bootmode detection ———
Boot.....Time:1160ms
Result: Bootmode=Handshake
  
```



Fig. 7-8: Output of the utility program

- ➔ Press the [Use] button to take over the port number, data transfer speed and boot mode settings for the respective interface into the system settings.



Note

Searching is only done in COM ports COM1 through COM6. Higher COM port numbers (COM7, COM8 etc.) are not detected.

If the utility program was unable to find the COM Port Detector, the following dialog box appears:

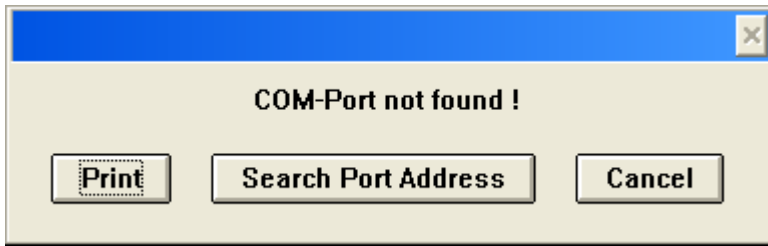


Fig. 7-9: "COM-Port Detector" error dialog

- Press the [Search Port Address] button to search for the Com Port Detector in the COM ports 1 through 6.
When a functioning COM port has been found, a number is output for this in "response".
- Configure this COM port in the Windows system control panel.

7.2.2 USB Port

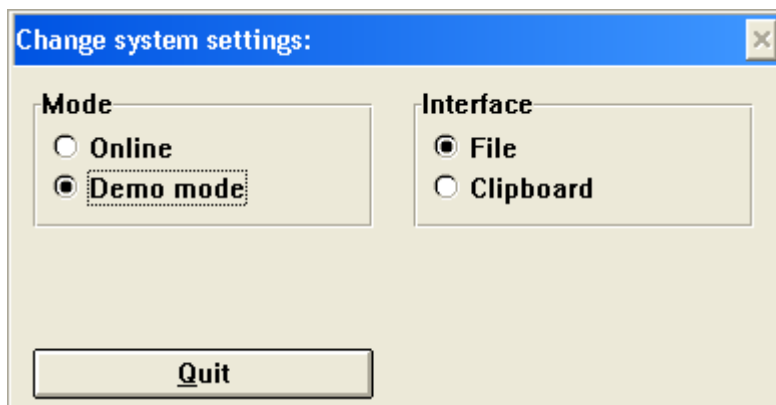


Fig. 7-10: "Change system settings" screen for the USB port

Note

The "Mode" setting is the same as that for the serial interface ([sect. 7.2.1, page 112](#)).



"Interface" settings

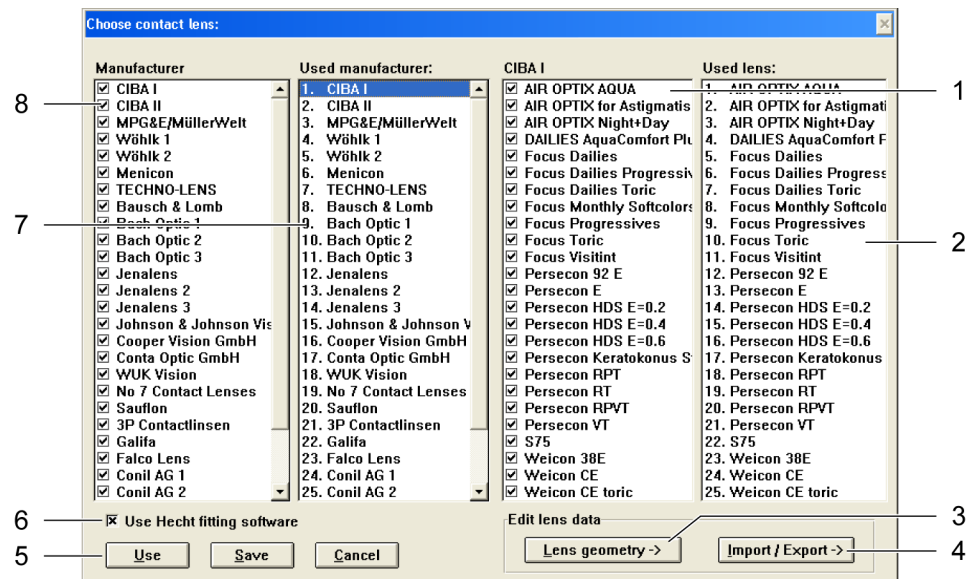
The keratograph software uses a utility program to communicate with the keratograph via the USB port.

- Make sure that the communication takes place by means of a file (option [File] is preselected).

7.3 Choose Contact Lens

A database is included with the Keratograph software which contains the posterior surface geometries of the contact lenses ([sect. 4, page 73](#)). For fitting contact lenses, you can specify the selection sequence for the manufacturer and lens type in the list.

- ➔ Press the button [Contact lens ->] on the "Change settings" screen. The "Choose contact lens" page appears.



- | | |
|-------------------------------|---|
| 1 List of all lens types | 5 [Use], [Save] and [Cancel] buttons |
| 2 List of contact lenses used | 6 Checkbox [Use Hecht fitting software] |
| 3 [Edit lens geometry] button | 7 List of used manufacturers |
| 4 [Import/Export->] button | 8 List of all manufacturers |

Fig. 7-11: "Choose contact lens" screen

In order to create a "Ranked list", proceed as follows:

- ➔ Deactivate all manufacturers in the complete list (8). The list of manufacturers is now empty.
- ➔ Switch on the manufacturer in the desired row. The suggestion list displays preferred lenses with a similar geometry from a particular manufacturer at the top.
- ➔ Now gradually select the applicable manufacturer (7) and deactivate all lens types from the corresponding manufacturer in the complete list (1).
- ➔ Now gradually switch on the desired lens types (2).



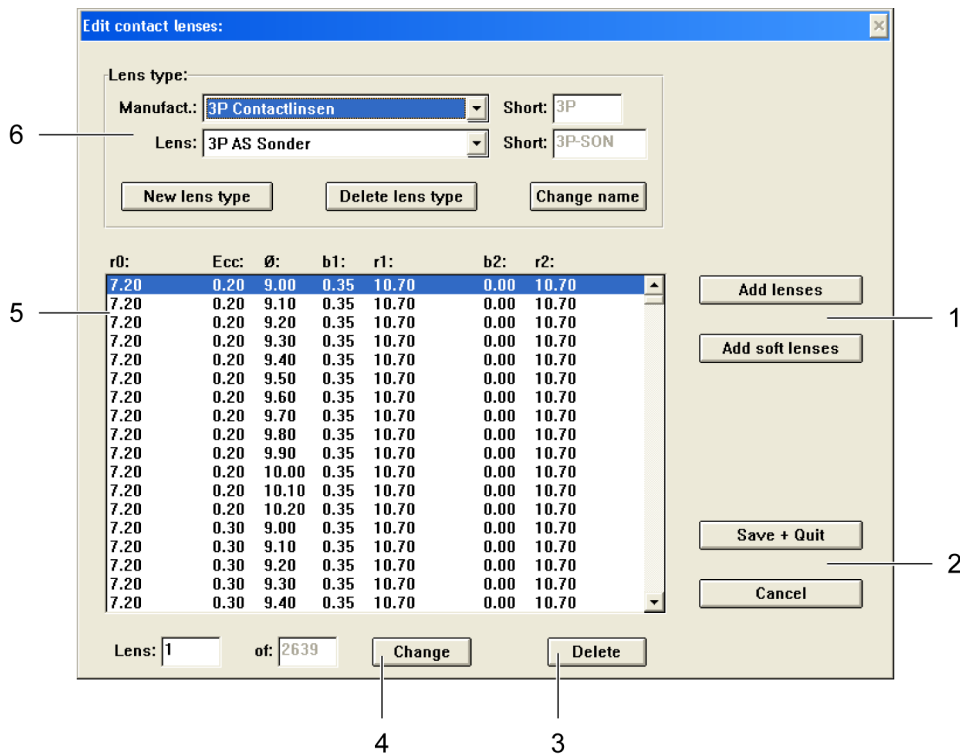
Note

The buttons [Use] [Save] and [Cancel] have the same function as those on the "Change settings" screen (Fig. 7-1, page 105).

You can also add new manufacturers, lens types, and lens data to the database and import/export the entire database. The procedure for this is explained in the following sub-chapters.

7.3.1 Editing lens geometry

- ➔ Select the manufacturer for which you want to edit or add contact lens data.
- ➔ Press the [Lens geometry ->] button. The following screen appears:



1 Add lenses/soft lenses

2 [Save + Quit] and [Cancel] buttons

3 [Delete] button

4 [Change] button

5 List of lenses of a particular type

6 Settings "Lens type"

Fig. 7-12: "Edit contact lenses" screen

- ➔ After all settings have been made, press the [Save + Quit] button to apply the changes, or [Cancel] to discard the changes.

7.3.2 Editing manufacturer data and lens types

- ➔ In the upper area (6), select if you would like to add a new lens type, delete the current lens type, or change the name, and then enter the corresponding information.

7.3.3 Editing individual contact lens data

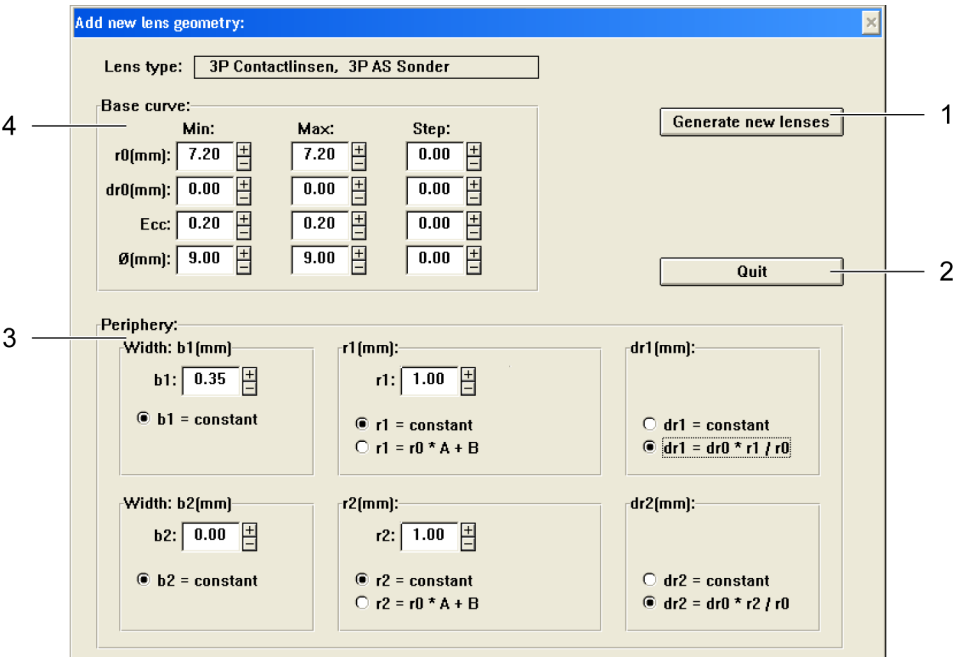
- ➔ In the list of contact lens data (5), select an individual lens and press the [Delete] button (3) to delete the data, or press [Change] (4) to change it.

7.3.4 Adding Rigid Contact Lenses

- ➔ To add a completely new lens, generate a new contact lens type (sect. 7.3.2, page 117) and enter the desired name.

Alternatively, you can insert a new lens into the existing list:

- ➔ In the top part of the screen, select the manufacturer and lens type for which you want to add a new contact lens.
- ➔ Click the button [Add lenses].
The following screen appears:



1 [Generate new lens] button

2 [Back] button

3 Settings "Periphery"

4 Settings "Base curve"

Fig. 7-13: "Add new lens geometry" screen

The following parameters have to be entered for every contact lens:

- **r0:** Curvature radius of contact lens at center - steep meridian for contact lenses.
- **dr0:** Curvature difference of main section at center for toric lenses - this value is "0" for rotation-symmetrical lenses.
- **Ecc.:** The eccentricity of the contact lens for aspherical lenses - this value is "0" for spherical lenses.
- **Ø:** Total diameter of contact lens.

A minimal value, maximum value, and a step length can be entered for every value. More lenses will be created later for which the data results from the individual values.

Example:

	Sphere			Toric lens			Asphere		
	Min	Max	Step	Min	Max	Step	Min	Max	Step
r0	7.20	9.60	0.10	7.20	9.60	0.10	7.20	9.60	0.10
dr0	0.00	0.00	0.00	0.30	1.00	0.10	0.00	0.00	0.00
Ecc.	0.00	0.00	0.00	0.00	0.00	0.00	0.40	1.00	0.10
Ø	9.30	10.30	0.50	9.30	10.30	0.50	9.30	10.30	0.50

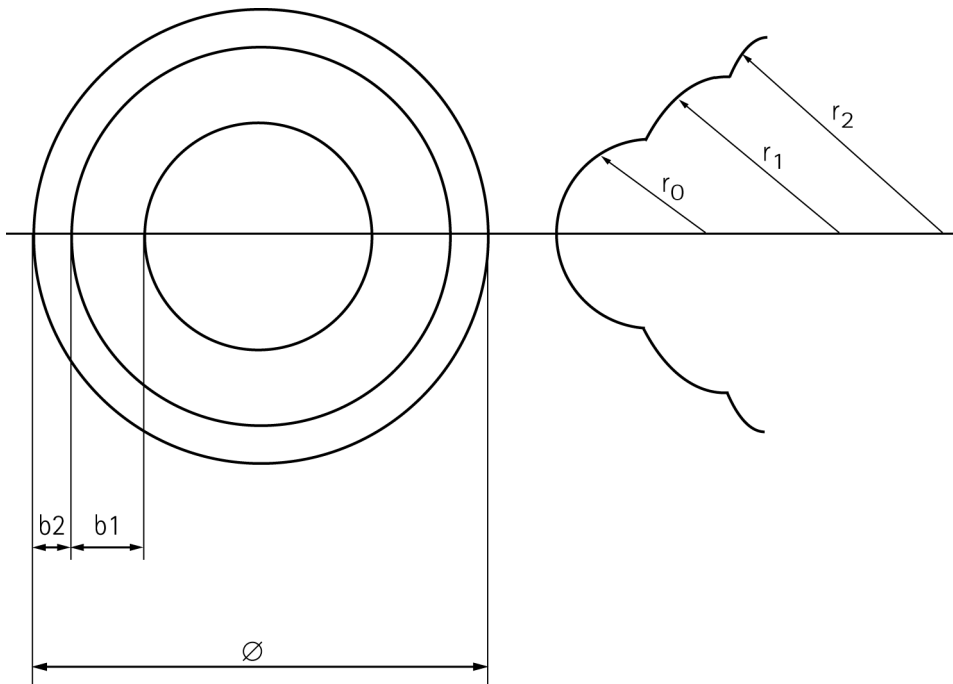


Fig. 7-14: Definition of the periphery

Besides the basic parameters, the peripheral values must also be entered in order to define multi-curve lenses and bevels. You can define up to two peripheral zones with the following three individual values:

- **b1** or **b2**: Width of Zone 1 or Zone 2.
- **r1** or **r2**: Curvature of Zone 1 or Zone 2. If the curvature is constant, select the option " $r1 = \text{constant}$ " or " $r2 = \text{constant}$ " and enter the curvature. If this is not the case, select the option " $r1 = r0 \cdot A + B$ " or " $r2 = r0 \cdot A + B$ " and enter the respective values "A" and "B".

Example 1: If the curvature in an edge zone is always 0.8 mm larger than the central radius $r0$, enter "1" for "A" and "0.8" for "B".

Example 2: If the curvature in an edge zone always amounts to 1.5 times the central radius $r0$, enter "1.5" for "A" and "0" for "B".

- **dr1** or **dr2**: Curvature difference of cornea for toric lenses. In case the curvature difference is constant, select the option " $dr1 = \text{constant}$ " or " $dr2 = \text{constant}$ ". If this is not the case then select the option " $dr1 = dr0 \cdot r1/r0$ " or " $dr2 = dr0 \cdot r2/r0$ ". This has the effect of transferring the ratio of the central radii to the periphery.

The individual zones are always linked, e.g. Zone 1 is the area outside of the basic area with the corresponding width.

Zone 2 is the area outside of Zone 1.

**Note**

- If you only want to define one peripheral zone, make sure that the value "0,0" is entered in the field "b2".
- For all other parameters of the second zone, the same values must be entered as those for the 1st zone.
- The value in field "b1" cannot be set to "0".

Examples

Rotation-symmetrical lens with bevel (0.8 mm larger than central radius)

b1 = constant	b1 = 0.25	
$r1 = r0 \cdot A + B$	A = 1.00	B = 0.80
dr1 = constant	dr1 = 0	
b2 = constant	b2 = 0.00	
$r2 = r0 \cdot A + B$	A = 1.00	B = 0.80
dr2 = constant	dr2 = 0	

Rotation-symmetrical lens with bevel (1.5 times central radius)

b1 = constant	b1 = 0.25	
$r1 = r0 \cdot A + B$	A = 1.50	B = 0.00
dr1 = constant	dr1 = 0	
b2 = constant	b2 = 0.00	
$r2 = r0 \cdot A + B$	A = 1.50	B = 0.00
dr2 = constant	dr2 = 0	

3-curve lens

b1 = constant	b1 = 0.40	
$r1 = r0 \cdot A + B$	A = 1.20	B = 0.00
dr1 = constant	dr1 = 0	
b2 = constant	b2 = 0.40	
$r2 = r0 \cdot A + B$	A = 1.50	B = 0.00
dr2 = constant	dr2 = 0	

Toric lens with bevel

b1 = constant	b1 = 0.25	
$r1 = r0 \cdot A + B$	A = 1.50	B = 0.00
$dr1 = dr0 \cdot r1 / r0$		
b2 = constant	b2 = 0.00	
$r2 = r0 \cdot A + B$	A = 1.50	B = 0.00
dr2 = constant	dr2 = 0	

- To finish, press the [Generate new lens] button.
The lenses will be created using the parameters entered previously.

7.3.5 Add soft lenses

- To add a completely new lens, generate a new contact lens type ([sect. 7.3.2, page 117](#)) and enter the desired name.

Alternatively, you can insert a new lens into the existing list:

- In the top part of the screen, select the manufacturer for which you want to add a new contact lens.
- Press the [Add soft lenses] button. The following screen appears:

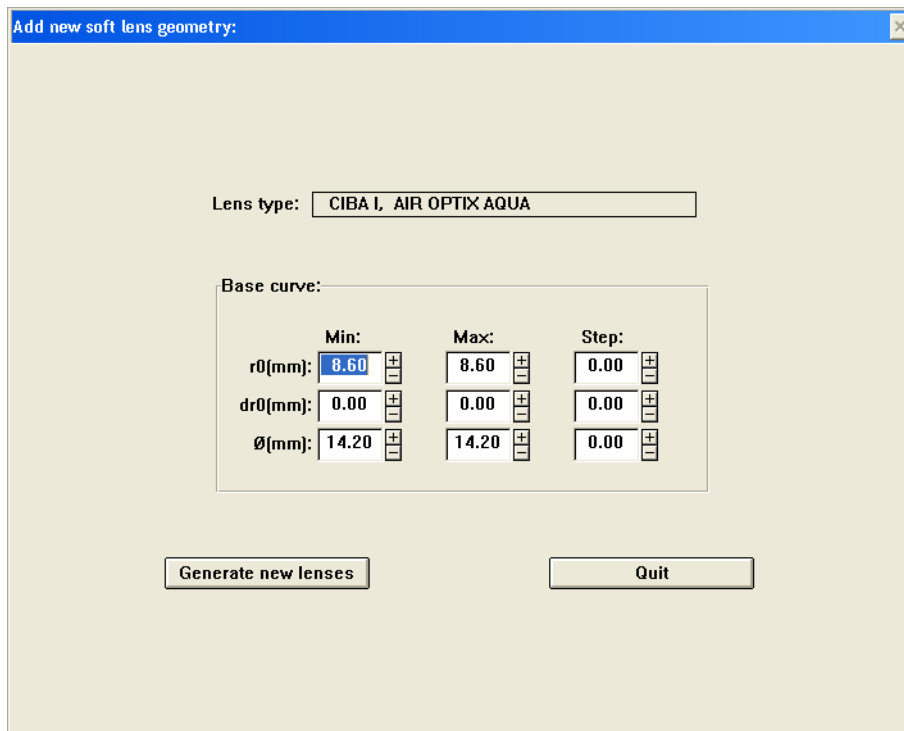


Fig. 7-15: "Add new soft lens geometry" screen

- Enter all of the parameters. Information about the individual parameters is given in the description of how to generate new, rigid contact lenses ([sect. 7.3.4, page 117](#)).
- To finish, press the [Generate new lens] button. The lenses will be created using the parameters entered previously.

7.3.6 Import and Export of Contact Lens Data

- Press the button [Import/Export ->] (Fig. 7-11, page 116) on the "Choose contact lens" screen. The following screen appears:

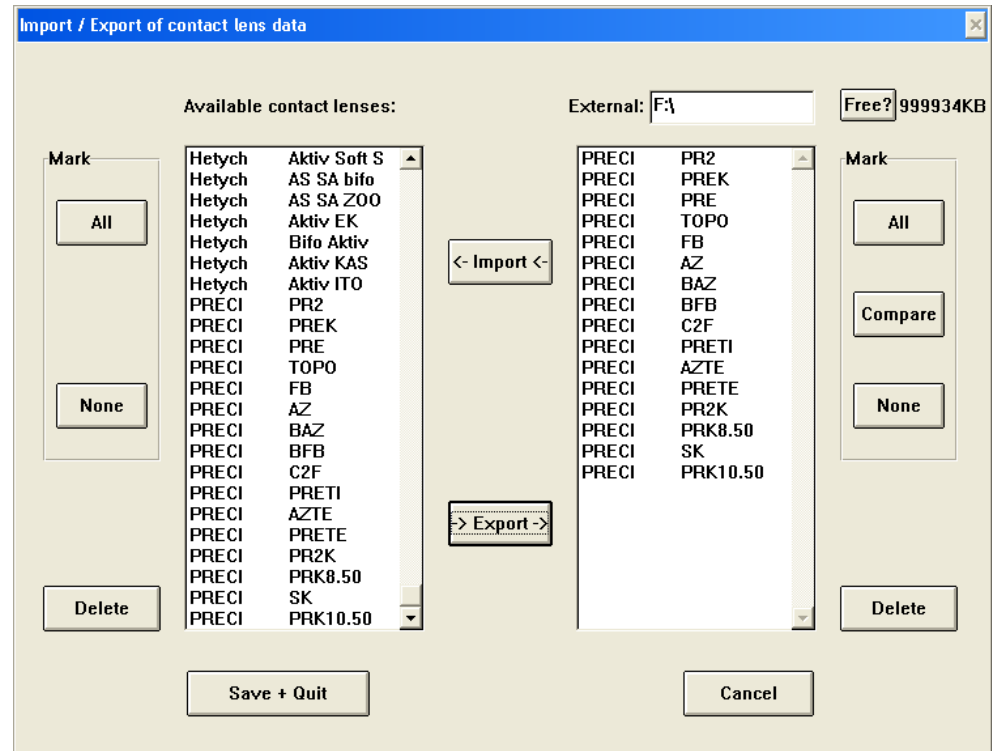


Fig. 7-16: "Import/Export of contact lens data" screen

All contact lens data that are presently saved on the PC are listed in the list on the left. All contact lens data that are saved in the directory selected in the "External:" field are listed in the list on the right.

Exporting Contact Lens Data

- In the "External:" field, enter the letter of drive and, if applicable, the sub-directory to which you want to export the data.



Note

To be able to select the sub-directory here, it must already exist on the data medium.

- Press the button [Free?], if necessary, to determine how much space is still available on the data medium.
- In the left list, select the contact lens data that you want to export. Use the buttons [All] or [None] in the "Mark" box, if applicable, to make an initial selection.
- Press the [-> Export ->] button to export the selected data.

If one or more of the selected contact lens types already exists in the target directory, a confirmation dialog box appears.

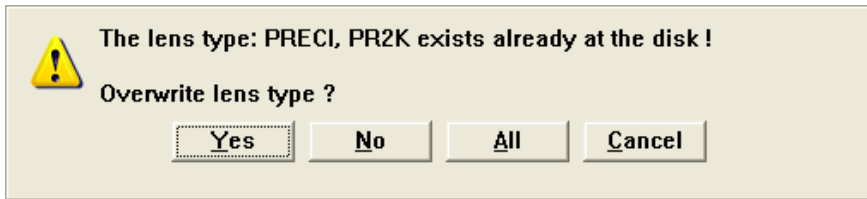


Fig. 7-17: Dialog box "Lens type already exists"

- Select the desired option.
- **Yes:** Only the selected lens type is overwritten.
- **No:** The selected lens type is **not** overwritten.
- **All:** All existing lens types in the target directory are overwritten without further confirmation being asked for.
- **Cancel:** Cancels the export of the contact lens data.

Note

The changes when exporting data are executed immediately after the [-> Export ->] button is pressed and the respective option has been selected, where applicable.



Importing Contact Lens Data

In principle, the import of contact lens data takes place in exactly the same way as the export.

- In the right hand list, select the contact lens data that you want to import. Use the buttons [All] or [None], if applicable, to make an initial selection.

Note

To import only those contact lens data that are on the external data medium but are **not** on the PC, press the [Compare] button in the "Mark" box. Only the contact lens data in question are then marked in the right hand list. This procedure is recommended for doing updates in which all existing data on the PC are kept and only new data from external data media are to be added.



- Press the [<- Import <-] button to import the selected data into the PC.
- Confirm in the confirmation dialog box, if applicable. The options are also the same as those for exporting data.
- To apply the changes, press the [Save+Quit] button to close the "Import/Export of contact lens data" screen

Note

The changes when importing data are only applied after the [Save+Quit] button has been pressed to close the "Import/Export of contact lens data" screen.



- To discard the changes, press the [Cancel] button to close the "Import/Export of contact lens data" screen.

Deleting Contact Lens Data

You can delete contact lens data both on the PC and on the external data medium.

- Select the contact lens data that you want to delete from either the left or the right list accordingly.
- Press the [Delete] button on the appropriate side. A confirmation dialog box appears.

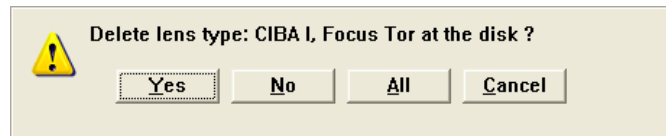


Fig. 7-18: Dialog box "Delete lens type"

- Confirm that you want to delete in the confirmation dialog box. The options are also the same as those for exporting data.

Updating the Contact Lens Data

In principle, a contact lens data update on the PC takes place in the exactly the same way as the import.

- Press the [Compare] button in the "Mark" group box. Those contact lens data that are present on the external data medium but **not** on the PC are marked in the list on the right hand side.
- Press the [<- Import <-] button to import the selected data into the PC.
- To apply the changes, press the [Save+Quit] button to close the "Import/Export of contact lens data" screen



Note

The changes when importing data are only applied after the [Save+Quit] button has been pressed to close the "Import/Export of contact lens data" screen.

- To discard the changes, press the [Cancel] button to close the "Import/Export of contact lens data" screen.

7.4 Video Settings

If you purchased and installed the imaging software after you initially purchased the unit ([sect. 5.1, page 89](#)), you must set the corresponding codec.

- Press the button [Video ->] on the "Change settings" screen. The "Select Code" dialog box appears.

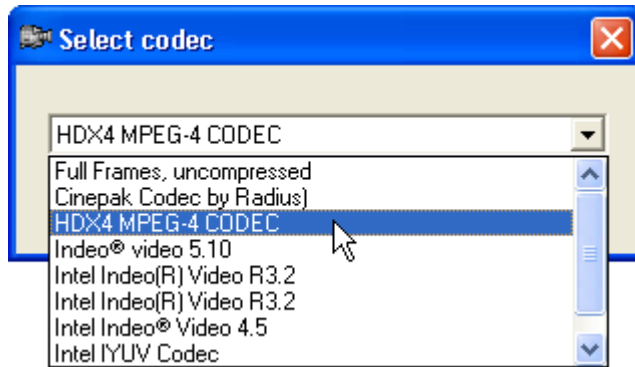


Fig. 7-19: Dialog box "Select X Codec"

- Select the desired code from the list.

Note

Messrs. OCULUS recommends the code "HDX4 MPEG-4 CODEC".



- Close the "Select Code" dialog box.
- Apply the setting by pressing the [Save] button on the "Change settings" screen.

8 Miscellaneous Functions

Note

The functions "Start Keratograph " and "Test Communication" can only be executed on units with a serial interface (e.g. Keratograph 2).



The "Miscellaneous" menu contains the following service functions:

■ Start Keratograph (for serial interface only)

- Restart the keratograph if the communication between the keratograph and the PC is disrupted.
- Click on "Start Keratograph".
- The message "Turn on keratograph" appears.
- Turn the keratograph off and then on again.
- Then press [OK] to start the data transfer from the PC to the keratograph.

(This function is also executed in the background every time the examination program is put into operation.)

■ Test Communication (for serial interface only)

- Click on "Test Communication".

The communication between the PC and the keratograph is tested.

If a keratograph with a serial interface (e.g. Keratograph 2) is being used, this function determines the error status of the PC. The number of corrected data packages and the quantity of transferred data are displayed.

The error rate (errors per minute) and the recommended data package size are determined from those values and are displayed. To check the data stream, the camera image also appears.

The communication status is displayed in the bottom line:

Communication OK

Error correction only very seldomly needed, data transfer is reliable.

Communication problematic

Errors occur frequently but could always be corrected up to now.

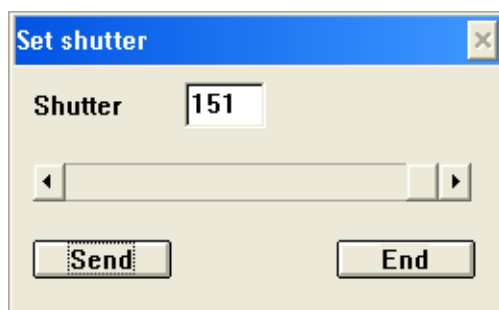
Communication very problematic

Errors occur very frequently and cannot always be rectified even after several correction attempts. You must use a smaller package size.

- Press the [End] button to end the communication test.

■ **Set Shutter**

- Use the slider control to set the shutter speed of the keratograph's electronic CCD camera:



- Press the [Send] button to confirm.
- Press the [End] button to end the operation.

■ **Set Ports**

Activate or deactivate the functions:

- Free
- Keratometer test marks
- Ring Illumination
- Glare ring